PUBLISHED EVERY SATURDAY BY
THE W. J. JOHNSTON COMPANY, Limited.
167-176 TIMES BUILDING, NEW YORK.
Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 28 Hathaway Building, Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR $3.
(Including Postage in the U. S., Canada or Mexico.)

Address all communications to
THE W. J. JOHNSTON COMPANY, Ltd.,
Times Building, New York,
OR ANY OF THE BRANCH OFFICES.

VOL. XXI. NEW YORK, JAN. 21, 1893. NO. 3.

CONTENTS.

EDITORIAL: PAGE
Paragraphs ... 41
ILLUSTRATED ARTICLES:
The Construction and Operation of Electric Fountains ... 42
Recent Progress in the Introduction of the Triphase System ... 45
Chronological History of Electricity, by P. F. Mottelay ... 47
Calculation of a Small Electric Motor.—I., by E. Meylan ... 48
The Calculation of Alternating Current Motors—I., by E. Arnold ... 49
The Tension in Ferranti Cables, by Dr. Behn Eschenburg ... 52
Experimental Researches on Alternate Current Transformers—III., by Dr. J. A. Fleming ... 52
Electric Engineering and Supply Company's Switch ... 54
A New Electric Lock ... 54
The Acme Storage Battery System ... 54
Duplex Magnets ... 54
A New Telephone ... 55
The Tice-Lintner Potential Indicator ... 55
The Turbayne Mast Arm Cut-Out ... 55
Automatic Safety Stop as Applied to Corliss Engines ... 56
The Diamond Transformer ... 56
The Heinze Electric Company's Cut-Out ... 56
MISCELLANEOUS:
Reversability of Three-Phase Motors with Induction Winding, by Ernst Danielson ... 44
Electrical Needs of the Times, by H. Franklin Watts ... 44
The Canadian Electrical Association ... 44
Experiments on the Conductivity of Insulating Bodies, by E. Branly ... 44
New Books ... 44
Werner Von Siemens: Some Additional Details Regarding His Life and Work ... 46
Transportation Rates to the National Electric Light Association ... 47
Electric Motors in Machine Shops ... 48
Proposed Telegraphic Tournament ... 48
Motors Without Counter E. M. F ... 49
Ewing's High Frequency Alternator and Parson's Steam Turbine, by Nikola Tesla ... 50
Report of the Sub-Committee on Provisional Programme for the International Electrical Congress ... 50
The Twin Arc Lamp: A Reply by the Electric Construction and Supply Company ... 54
Another Three-Pnase Current Installation ... 54
A Novel and Useful Souvenir ... 56
FINANCIAL INTELLIGENCE: The Electrical Stock Market, 57; New Incorporations, 57.
SPECIAL CORRESPONDENCE: New York Notes, 57; New England Notes, 58; Philadelphia Notes, 58; Pittsburgh Notes, 58; Western Notes, 58.
NEWS OF THE WEEK: The Electric Light, 59; The Electric Railway 59; Miscellaneous Notes, 59.
INDUSTRIAL AND TRADE NOTES ... 59
BUSINESS NOTICES ... 60
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 60

Publications of the W. J. Johnston Co., Ltd.

THE ELECTRICAL WORLD. An Illustrated Weekly Review of Current Progress in Electricity and Its Practical Applications. Subscription, in advance, one year ... $3.00

JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY, Containing Lists of Central Electric Light Stations, Isolated Plants, Electric Mining Plants, Street Railway Companies—Electric, Horse and Cable—with detailed information regarding each; also Lists of Electrical and Street Railway Manufacturers and Supply Dealers, Electricians, etc. Published annually ... 5.00

THE TELEGRAPH IN AMERICA. By JAS. D. REID. 894 royal octavo pages, handsomely illustrated, Russia ... 7.00

DICTIONARY OF ELECTRICAL WORDS, TERMS AND PHRASES. By EDWIN J. HOUSTON, A. M. Second edition, entirely rewritten. 5,000 definitions, 562 double column octavo pages, 570 illustrations ... 5.00

THE ELECTRIC MOTOR AND ITS APPLICATIONS. By T. C. MARTIN and JOS. WETZLER. With an appendix on the Development of the Electric Motor since 1888. By Dr. LOUIS BELL. 315 pages, 353 illustrations. 3.00

THE ELECTRIC RAILWAY IN THEORY AND PRACTICE. The First Systematic Treatise on the Electric Railway. By O. T. CROSBY and Dr. LOUIS BELL. Octavo, 400 pages, 179 illustrations ... 2.50

ALTERNATING CURRENTS. Treated Analytically and also Treated Graphically. By FREDERICK BEDELL, Ph. D., and ALBERT C. CREHORE, Ph.D. Uniform in size and style with Crosby & Bell's "Electric Railway" ... 2.50

PRINCIPLES OF DYNAMO-ELECTRIC MACHINES and Practical Directions for Designing and Constructing Dynamos. By CARL HERING. Sixth thousand, 279 pages, 59 illustrations ... 2.50

ELECTRIC LIGHTING SPECIFICATIONS for the Use of Engineers and Architects. By E. A. MERRILL. 175 pp. 1.50

THE QUADRUPLEX. By WM. MAVER, JR., and MINOR M. DAVIS. With Chapters on Dynamo-Electric Machines in Relation to the Quadruplex, Telegraph Repeaters, the Wheatstone Automatic Telegraph, etc. 126 pp., 63 illustrations ... 1.50

THE ELEMENTS OF STATIC ELECTRICITY, with Full Description of the Holtz and Töpler Machines. By PHILIP ATKINSON, Ph.D. 228 pages, 64 illustrations ... 1.50

LIGHTNING FLASHES. A Volume of Short, Bright and Crisp Electrical Stories and Sketches. 160 pages, copiously illustrated ... 1.50

ELECTRICITY AND MAGNETISM. A Series of Advanced Primers. By EDWIN J. HOUSTON, A. M. ... 1.00

RECENT PROGRESS IN ELECTRIC RAILWAYS. Being a Summary of Current Advance in Electric Railway Construction, Operation, Systems, Machinery, Appliances, etc. Compiled by CARL HERING. 386 pages, 120 illus. ... 1.00

ORIGINAL PAPERS ON DYNAMO MACHINERY AND ALLIED SUBJECTS. Authorized American Edition. By JOHN HOPKINSON, F. R. S. ... 1.00

DAVIS' STANDARD TABLES FOR ELECTRIC WIREMEN. With Underwriters' Rules, Instructions for Wiremen and Linemen, Plates of Circuits and Useful Data. Third Edition. Revised by W. D. WEAVER ... 1.00

Counter Electromotive Force. POOR Jacobi! how sad it would make him feel to see how his valuable law had been butchered at the hands of those who fail to grasp it! The latest explanation of it is unique: The C^2R loss in a motor is that part which does the work (of destruction?) while the poor innocent generator is credited with incapacity, and is blamed for the existence of what amateurs find the most tantalizing feature about electric motors—the counter electromotive force.

Beginning the New Year Wrongly. FROM a time beyond which the memory of man runneth not back, the beginning of a new year has been considered an appropriate time for turning over a new leaf and starting afresh on the straight and narrow path. But there is an old saying that "resolves that are made in the morning must not be judged by actions at night." Following out this injunction, we have glanced over the columns of some of our daily contemporaries of Jan. 1, with a view to determining the prospect of an improvement in the accuracy of their electrical news (?). The results seems to indicate that the electrician will continue to be amused and the layman to be misled as much in the future as in the past, as witness the following: One of the prominent New York dailies, after felicitating itself over a phenomenal increase in its circulation during the past year, undertakes a review of the topics of chief interest during that period. Under the heading "Electricity" it credits Edison with having "invented in about five minutes, during the Chilian war agitation, an arrangement by which a stream of water charged with a powerful electric current would mow down men by the thousands." This, it says, "was a very complete invention." Edison is also credited with having "devoted some time to the question of curing baldness by electricity," which, however, was not so complete. It also informs us that in the Frankfort-Lauffen experiment power was transmitted 108 miles with a loss of but 10 per cent. In another portion of the same paper it states that "a German inventor has taken out patents on an incandescent lamp having three independent carbon lamps and three terminals," and concludes with the sapient remark that "the lamp is probably invented to use on a *three-wire circuit*." The topics of most interest to the American people as given by the same authority, in the order of their importance, are as follows: Money, Politics, Women, Sport, Electricity, Religion and Art.

Missionary Work of the N. E. L. A. NOT the least of the benign results of the meetings of the National Electric Light Association are those which follow in its wake as a band of missionaries. Thus the Montreal convention stirred into activity, or rather, we may say, gave birth to an interest in electrical matters throughout the provinces undreamt of before. In fact such an awakening followed in its steps as would have gladdened the heart of an exhorter at an old time camp meeting, and directly traceable to its influence were the organization of the now prosperous Canadian Electric Association and the springing into existence of several new electrical publications. In our own country its influence for good has been no less in fact, though less striking to the eye by reason of fainter shadows to mark the contrast, but everywhere it goes it leaves its imprint behind. Not only this, but it casts its radiance ahead illuminating the path which it must itself travel. A noteworthy illustration of the latter is called to mind at this time by the announcement in the last issue of the organization and housing, with most flattering prospects for the future, of the Electric Club of St. Louis. That city has not been wanting, heretofore, in electrical enterprise, as witness her unsurpassed system of electrical railways, her extensive arc and incandescent lighting stations, unequaled in point of size, by any in this country or abroad, and the boldness of the conception of the St. Louis-Chicago electric railway, now in process of construction. Nor has she lacked the material from which to draw; but heretofore she has been without a home for the electrical fraternity. A sort of inertia seems to have prevailed, which only required to be overcome by some sufficient influence, to start the ball a-rolling, which, when once in motion, will be the more difficult to stop by reason of this very inertia. That influence was the approaching convention of the National Electric Light Association, and St. Louis now prides herself on having an electric club and quarters for its meetings equal to anything of the kind in the country.

Illuminated Fountains. IN this issue we devote more space than is usually allotted in a single number to any one subject to an interesting historical sketch of illuminated fountains and to a description of the latest triumph in this branch of art, viz., the electrically illuminated fountains at the World's Fair. Accompanying this article are a number of very handsome engravings, including a two-page supplement prepared especially for this occasion. The latter, undoubtedly the handsomest illustration ever produced for an electrical or other trade journal, is printed on heavy paper suitable for framing, and will be sent under separate cover. Every subscriber to THE ELECTRICAL WORLD is entitled to a copy of this magnificent picture, and should any fail to receive it the omission will be corrected by communicating the fact to this office. The subject of illuminated fountains has been very fully treated from a historical standpoint, and the arrangement of lights and the methods of manipulation by which such startling and brilliant effects are produced are fully described. Those who have seen the electrically illuminated fountains abroad or the one now located at Lincoln Park, Chicago, need not be told that the highest posibilities in color effects are by this agency within our grasp. The hint that the study of thin rock sections by transmitted polarized light may be the means of supplying us with unlimited harmonious combinations of color is a good one; and that other hint that the illuminated fountain may prove a most effective means of inducing traffic on suburban electric railroads is one that is likely to be promptly acted upon. In one of the two Western electric roads referred to, that are already installing plants of this kind, it is the intention to take the electrical supply direct from the trolley or feeder wires. In this same installation, too, electricity from the same source will drive the pumps for the water supply. Thus it will be seen how appropriately the electric fountain fits in as an adjunct to electric railway systems. Mr. Luther Stieringer, the consulting electrician of the Columbian Exposition, who has designed and arranged all the details of this magnificent work of art—for such it is—will win for himself a place in the world of artistic illumination similar to that he already occupies in the more prosaic but more utilitarian field in which he is so well and favorably known.

The Electrical Congress. IN the present issue we publish the suggestions made by a committee of the American Institute of Electrical Engineers for the programme and the work of the next Congress to be held in Chicago in August. It will be noticed that the report is in the form of suggestions only, as this committee, of course, has no authority. The report sums up the numerous suggestions made from time to time regarding units, names, nomenclature and other similar matters which ought to be adopted and made the same all the world over; if they are not, the uniformity of our otherwise rational and nearly perfect system of units and terms will no longer exist. Certain units like those for measuring and representing magnetic quantities and illumination are badly needed, as is also some reliable, simple, and constant unit of light to replace the very unsatisfactory and nearly useless standard candle. If some concerted action is not taken at this Congress different parties will find themselves compelled to adopt some units, the result of which would doubtless be the introduction of a number of different units for the same quantities. The report ought to be received favorably in England, as it contains much that the Englishmen themselves have suggested and adopted, in relation to concrete standards. That they will object to some points is almost certain, yet in an international agreement all parties ought to be ready to yield on some points, otherwise harmonious action will never be reached. If any one finds important objections to some of the suggestions let him propose something better. The committee suggests that an international discussion be conducted in the foreign and American electrical journals, in order that any one may offer his suggestions or criticise those of others. This appears to be the best way to conduct an international discussion in the short time that is left. The work of the Congress will then be limited to deciding which of the many suggestions shall be adopted, and it will be relieved of the long and time-robbing and practically endless discussions at the meetings, where time is so valuable. At the Paris Congress of 1889 all the matter was prepared beforehand, and the formal adoption occupied but a few minutes. At Frankfort in 1891 this was not the case, and the result was hasty and somewhat unsatisfactory work, while other matters of greater importance had to be left undone for want of time to consider them properly. In the present report the committee states that a congress is the place to close and not to open the discussion of units. The magnetic units suggested are all based on the absolute system and they therefore require no experimenting to determine them, but the unfortunate unit of light requires some attention. The Paris Congress of 1884 adopted the platinum unit of light, which is the amount of light emitted perpendicularly from a square centimetre of incandescent platinum at the temperature of solidification. The intensity of this light per square millimetre of incandescent surface is about eleven times that of an equal surface of the flame of the Carcel lamp, and it is, therefore, probably a very white light, which makes it a better absolute unit than a yellow candle. The whole light from this unit is a close approximation to twenty candles. The practical unit adopted in 1889 is one-twentieth of this, called the *bougie decimale* (that is, decimal candle), which is, therefore, practically equal to a candle. If this platinum standard is capable of being reproduced with reasonable accuracy, about which there seems to be some doubt, there is no reason why all the world should not adopt the *bougie decimale* as the practical unit. It could even be called a candle in English, as the present candle is a very indefinite quantity anyhow. The committee suggests that a small amyl acetate lamp, defined by its dimensions and by the height of the flame, giving one *bougie decimale*, be adopted as the commercial concrete standard. This would greatly simplify the question of a simple practical standard of light, as such lamps appear to be very satisfactory, almost any one being able to use them without the slightest difficulty.

Construction and Operation of Electric Fountains.

TRACING our steps back to the age of fable—that dreamy and distant past, when the winds and the waves and the thunderbolt were personified as deities who ruled their realms with more or less fickleness of purpose—returning to those times when gods communed with men and measured out punishment or reward according to the vagaries of their humor, Alpheus, a river god, and son of Oceanus, wooed, but failed to win, the love of Arethusea, who, flying from him to the island of Ortygia, was there transformed into a living fountain. Alpheus, however, followed her under the sea, and, finally discovering her wherabouts, was joined with her in wedlock. This junction of the fountain to the mightier river is beautifully symbolic of the marriage relation of the present day, in which the dependent bride leans upon her sturdier spouse for support and sympathy in her varying moods.

According to another legend, Cyane, also a water-nymph, attempted to assist Arethusea in her flight from Pluto, for which she was changed by him into a fountain. Later, and within historical times, we find the fountain employed in the Church as symbolical of purity and eternal life; hence the baptismal font and the holy water, which have been perpetuated to this day. Then from an emblem of the Church, it descended to a lower level, and found its way into the temples of Mammon and became the type of sensualism and luxury. With the rise of aristocracy and wealth, it again became a central figure, but this time in the domain of art, and in the ruins of decadent Persian, Egyptian and Grecian empires we find in many places a record of the esteem in which it was held by those luxury loving peoples, already emasculated by a life of ease and sensuous surroundings. As the classic Greeks saw in the fountain the whim of one or the other of their deities, an instance of divine interposition with their crude ideas of natural laws, so in later times we find an innate belief in its supernal powers, which led the ancient navagators in search of the fountain of perpetual youth.

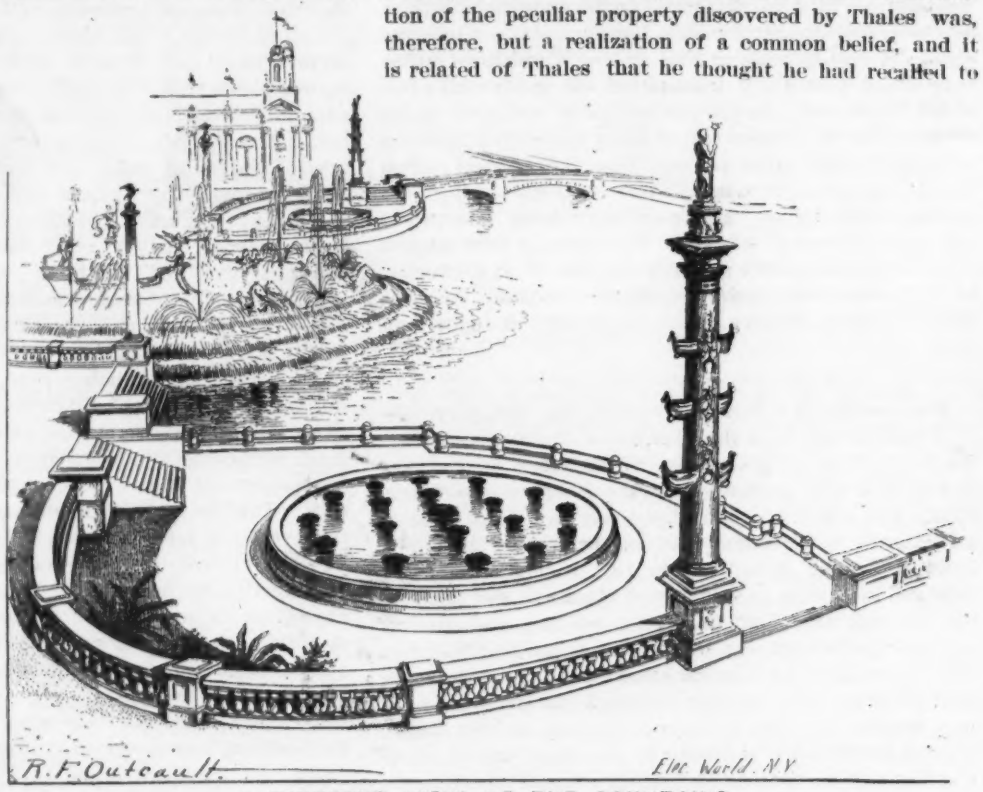
The beautiful effects of the splashing water, the murmur of its trickling streams, the increasing restlessness of its pulsating jets, were a fitting setting for the dreamy personifications which the fertile Oriental mind conjured up. Thus has the sculptor found here his greatest inspiration, and the beautiful myths of long ago are again endowed with life, and the stone or bronze is made to speak as was the beautiful Galatea in answer to the prayers of Pygmalion. But, since the early times, the setting of the sun marked the close of the day, these speaking fountains became mute as the veil of night was drawn, only to be awakened to consciousness again by the gentle touch of Lucifer, Aurora's avant courrier.

Since our modern civilization has converted night into day, so have the hours of life of the fountain's play been prolonged by the rays of artificial illumination. New and beautiful effects were produced by side lights and the poetic instinct clothed the flowing waters with a halo of mystic meaning and association that have stimulated our inner thoughts to flights of fancy, less sensuous in its degrading sense, more sensuous in its nobler imagery.

It is not definitely known when or how the first illuminated fountain was put into action, but it probably dates far back into the mists of time. In modern times, however, we hear of many attempts in this line. In these oil and candles or fagots were probably the source of light which, by the aid of reflectors, cast their rays upon the sparkling jets. Later, gas and the Drummond or calcium light, with their intensified rays, gave greater brilliancy to the living picture, and color was added by the interposition of colored media in the path of the rays. But while this latter step increased the brilliancy of the spectacle, the side lights cast a blur upon it, and the clearness of contrast was destroyed or impaired. With the advent of electrical illumination, new possibilities at once presented themselves, and the powerful rays from the arc lamp, reduced to approximate parallelism by means of parabolic reflectors, were directed upon the playing waters with beautiful and poetic effect. The first attempts in this line employed the sidelight arrangement, and, although the effects of color were striking and handsome, the glare of the lamp itself destroyed the best effects, and these attempts, though many, have all been abandoned as lacking in that essential, the appearance of jets of liquid gems of purest color.

As the origin of the fountain has been sought in mythical lore, so may we also trace the source of its new illumination to a similar origin.

To Thales, of Miletus, the earliest of Grecian philosophers, himself of Phoenician descent, however, is given the credit of first having observed the electrical properties of amber when briskly rubbed. The attraction which this resin displayed for light bodies was thought to be the outward manifestation of an immortal soul resident within in a state of passive existence, but awakened to action by the warmth of gentle friction. To personify this soul, no stimulus was required, for the ancient Phoenicians, like many other contemporaneous peoples, endowed each inanimate object with a living spirit, which some time would be called to life to work their weal or woe. Thus the pieces of amber cast up on the shore by the waves were petrified tears of maidens who sought surcease of sorrow for unrequited love by oblivion in the depths beyond. The manifestation of the peculiar property discovered by Thales was, therefore, but a realization of a common belief, and it is related of Thales that he thought he had recalled to



A BIRDSEYE VIEW OF THE FOUNTAINS.

being the soul of a virgin who in life had been so pure and lovely in character as to bring to her feet even inanimate objects, attracted thereto by her gentle ways, and their adoration of her immaculate personality. This virgin, he said, would henceforth live, and by her beneficent radiance illumine the darkened world. How prophetic this seems in the light of the present day! Thus amber, the symbol of light and purity, the enemy of all darkness and crime and foul disease, was highly prized by the people of ancient times, and pieces were worn as amulets to ward off and guard the wearer against all evil influences. What a beautiful genesis, therefore, had the electric fountain of the present day, as revealed to us by mythical lore!—the water with its restless passion the symbol of eternal life, and amber-soul the type of all that is pure and lovely—with such progenitors surely much was to be expected.

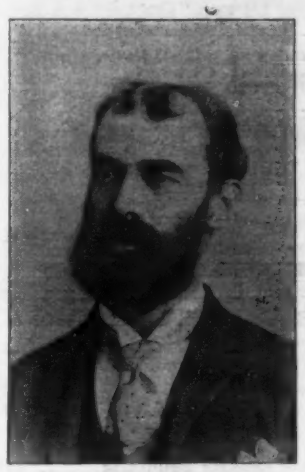
The first electric fountain illuminated in the direction of the jets was built and patented in 1884 by Sir Francis Bolton. The next in point of time was that constructed to meet the demand for out-door evening entertainment on the occasion of the great conventions in 1886, known as the Healtheries, Inventories, Fisheries and Colonies. This was laid out on the same lines as the first, and in connection with music by Strauss' Orchestra, the Cold Stream Guards and the Scotch Fusileers, proved at once an immense success and saved the conventions from utter failure. In recognition of his distinguished services on this occasion, Sir Francis Bolton was knighted.

The patents under which this invention is controlled are exceedingly broad, covering in general terms the illumination of jets of water by rays of light parallel to their axes from concealed sources of illumination.

The extreme beauty and novelty of the effects at once attracted the attention of Mr. W. Dwight Wiman, then traveling in England, who sought out Sir Francis Bolton and purchased from him in the name of his father, Mr. Erastus Wiman, of New York, the exclusive right to use the patents in the United States.

Returning to this country Mr. Wiman at once constructed a fountain on the lines covered by the patents which he controlled, and with the assistance of Mr. Stieringer, now the efficient consulting electrician of the World's Fair, put it into successful operation at St. George, on Staten Island.

This installation involved an expenditure of nearly $40,000, besides considerable ingenuity to bring it to the state of perfection it has now reached. After a brief season at Staten Island, it was purchased by Mr. Yerkes, the North Side street railway magnate of Chicago, by whom it was presented to the city and erected in a basin in Lincoln Park. Here it has attracted most marked attention, the open spaces surrounding the pool being packed nightly on the dates of the exhibition. The electric fountain at the Glasgow exposition, after designs by Galloway, followed, and the next of this kind was erected at the Paris Exposition of 1889.



Mr. Luther Stieringer, Designer of the Electrical Fountains.

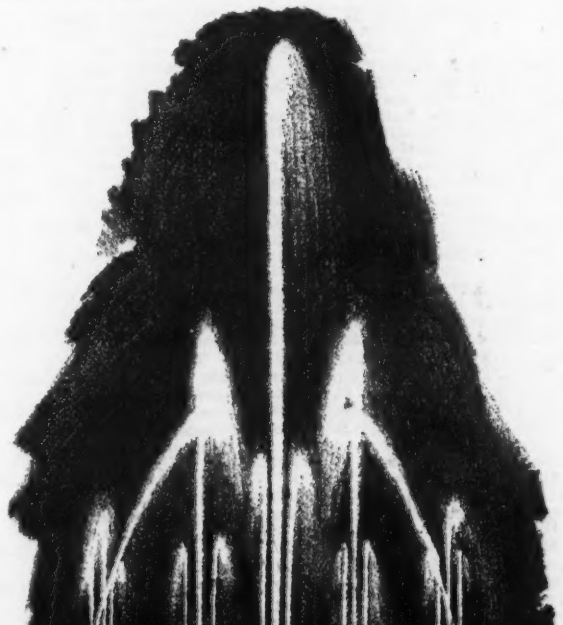
Similar fountains have been erected in Manchester and Liverpool, and more recently a smaller one has been placed by M. Gustave Trouve, of Paris, on the grounds surrounding the chateau of Madame Nicolini, at Craig-y-nos.

In the centre of the basin is excavated a pit about 8 feet deep, in which are located the valves, lamps and other operating mechanism. The roof of this chamber, which is flush with the bottom of the basin, is pierced with as many apertures as there are groups of jets, and these are continued upward to the surface of the water by cylinders closed with heavy transparent glass. Above these the water issues in jets from goose-neck pipes, either vertically or at an angle, as is desired. Within the chamber are arranged convenient for use the variously colored screens which are from time to time interposed in the path of the rays of light from the parabolic reflectors immediately beneath.

The Expcsition of 1889.

The fountains at the Paris Exposition may be described as a combination consisting of two parts, one the French and the other the English.

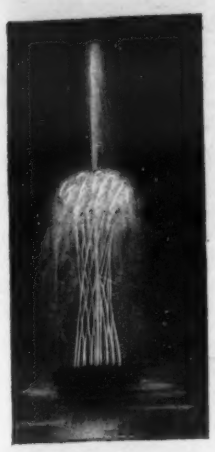
The central group is an allegorical representation of the city of Paris, in the centre of a large basin, which overflows into a lower one of rectangular shape, through four horns of plenty, four dolphins and six urns, forming altogether fourteen parabolic horizontal jets. Besides this there are two vertical jets placed on either side of the group.



A Set Piece.

The illumination of the jets is effected by means of seventeen arc lamps taking 60 amperes each for the English section, which was the last described, and 30–40 ampere lamps for the remainder, which comprises the French section. These in the aggregate would give an illuminating capacity of nearly 250,000 c. p., and require 250 h. p. for their operation.

Upon the proper handling of the colors depends much



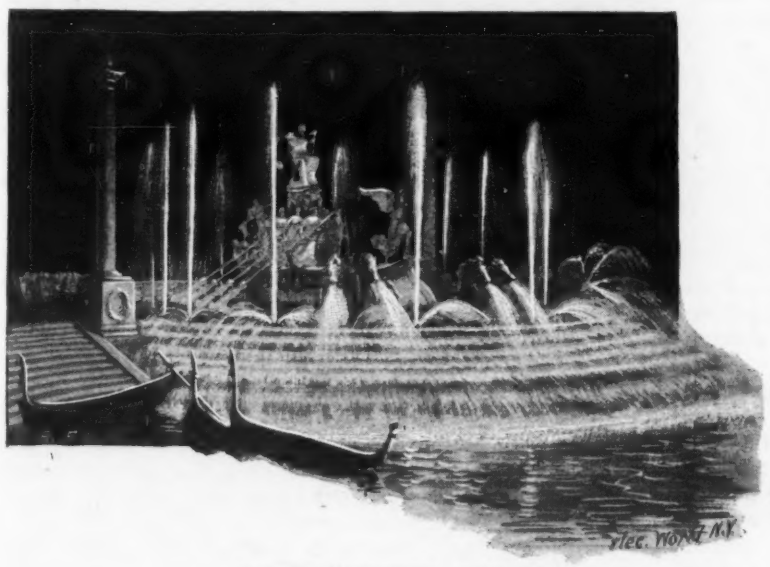
THE WHEAT SHEAF.

of the success and beauty of a display of this kind, for discord of color is as painful to the eye as is discord of musical notes to the ear. The science of optics discloses to us those colors which may be harmoniously blended, just as that of music tells us what notes will accord together. With light, however, we have an infallible guide in nature itself, any departure from which results in discord. In the study of the sections of rocks by transmitted polarized light, we have the perfection of blending of colors, for by revolving the analyzer through 90 degrees and 180 degrees, the brilliant contrasts of the first appearing colors are replaced by the equally harmonious contrasts of their supplementary hues.

SET PIECES.

Among the set pieces that have thus far been most extensively used may be mentioned the criss-cross fence. This is produced by a circle of composite jets, each consisting of three streams—the central one vertical and the other two inclining away from it at an angle of about 45 degrees. If the composites are placed close enough together the inclined jets cross each other and descend in graceful curves to the lake below, forming in livid light a wicker fence. By increasing the pressure of water, each jet is broken into spray, forming a solid hedge of prismatic hue, in keeping with whatever color or colors form the centre of the picture.

The sheaf of wheat is another accessory that has met the popular approval, and with yellow light is one of the prettiest borders for the more prominent figures in red, blue and white within. What is known as the centre jet effect is very startling and beautiful; beginning with the criss-cross fence in ruby red, the central vent is suddenly opened and a shaft of crystal white shoots up, and its falling spray tinged by reflection with ruby tints at once wins popular favor. The effect of a sudden burst of steam at the same time, enhances its beauty, lending to the picture the cloud effect. With the addition of yellow light, the most gorgeous sunrise and sunset colors are at once produced. In fact, the use of steam may be advantageous in many of the combinations, and never seems to tire the spectators.



THE McMONNIES FOUNTAIN.

But, still more startling is the rocket. For this a circle of jets inclined toward the centre and the central vent are brought into play. Yellow or red light are preferable for this. Suddenly these outside jets are closed, and the water-hammer caused thereby throws the central jet to an enormously greater height than that due to the head of water. At the moment of closing the outside jets, the color of the central stream is changed to white, and the simultaneous admission of steam completes the picture. But the water-hammer effect is but momentary, and the jet having reached its maximum height descends at once to the normal. Before this has occurred, however, the outside jets are turned on again with appropriate colors, which, reflected in the steam, produce a spectacle of unsurpassed grandeur.

Of course, many changes may be rung on these combinations by lowering or increasing the heights of the streams and substituting other harmonious colors. A favorite method is to arrange the border jets in such a fashion as to symbolize or represent the outside petals of a flower—a lily, for instance. If these be white and the central fitting be red, or vice versa, the contrast between the two and between them and the black background of the sky is bewildering beyond comparison.

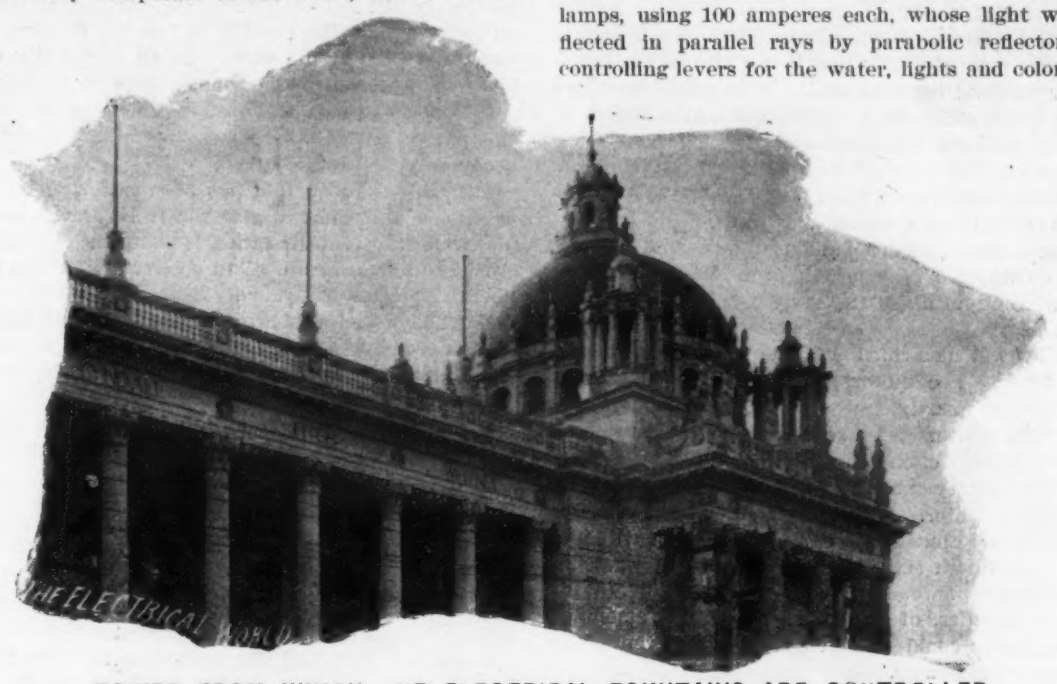
The coloring of the streams in electrically illuminated fountains surpasses by far, in depth and richness, that of gems of the purest water. The yellows are veritable jets of molten gold; the blues are liquid sapphires; the greens are ropes of emeralds and the reds are rubies rare. The steam partakes of all these hues, and the whites are driven snow or chains of sparkling diamonds.

THE FAR WEST

There are now in process of construction by different street railway companies in the West, which for the present shall be nameless, two electric fountains similar to though surpassing in beauty any of those referred to. These will be placed at or near the suburban termini of their roads as an inducement to travel on summer evenings. That they will meet the highest anticipations of their projectors has been more than assured by Mr. Yerkes' experience in Chicago. But by far the most elaborate installation of the kind ever attempted in this or any other country is that at the

WORLD'S FAIR.

most beautifully illustrated by Mr. Outcault in connection with this article. The views, as given, are not ideal, but are exact representations of some of the set pieces, as far as they have been decided upon by those in charge. They lack, however, the brilliancy and color which neither pen nor brush can possibly portray.



TOWER FROM WHICH THE ELECTRICAL FOUNTAINS ARE CONTROLLED.

Directly in front of the Administration Building and facing the Inner Harbor and the noble Peristyle, will be located this most gorgeous display. In the centre is placed the allegory of Columbus' voyage of discovery—a ship urged on by virgins typical of the arts and sciences, and guided by Father Time and the miniature cascade, through which the water flows to the Inner Harbor. This has been so well described before as to need no further comment. On either side will be located the electric fountains in circular basins 60 feet in diameter. Beneath the floors of these basins there have been excavated the chambers necessary for the manipulation of the water, lights and colors. The bottoms of these extend to a depth of four feet below the level of the Grand Lagoon or harbor, upon which they front, being protected from inroads of water therefrom by three thicknesses of sheet piling carefully calked to render them watertight.

The water is furnished by the Worthington pumps located at the eastern end of Machinery Hall and conveyed thence to a point near the basins by a 36-inch main. At this point a Y is formed which distributes to the two fountains the supply to each through 24-inch mains.

In each basin there will be located eighteen composite orifices, arranged symmetrically around the grand central jet, which will throw a stream two inches in diameter to a height of from 100 to 150 feet. Immediately surrounding the jet, and completing the central composite, will be arranged seven other jets, each throwing a stream of ⅝ inch diameter.

Circling about this central group are six other composites, each with a central jet of 1¼ inches, and seven surrounding ones of ⅝ inch. Surrounding these are still others, arranged in symmetrical order, each with its central vent surrounded by groups of seven lesser ones. In all, there are nineteen composites, each comprising eight jets, making 152 streams, or 304 for both basins. These will be illuminated by thirty-eight arc lamps, using 100 amperes each, whose light will be reflected in parallel rays by parabolic reflectors. The controlling levers for the water, lights and colors will be located in the chambers beneath the pools, but will be directed by electrical signals from the northeast tower of Machinery Hall, which overlooks the entire display.

A feature not before mentioned is the concealment from view of the nozzles of the jets and the glare of the lights below. This will be effected by surrounding each composite by clusters of cat-tails or other aquatic foliage in bronze; thus each group of jets will seem to issue from a floral piece, conventional, perhaps, but artistic withal.

MR. FREDERICK MCMONNIES,
The Designer of the Columbien Allegory.

In addition to the lamps within the subaqueous chambers, a powerful concealed search light will cast its rays from either side upon McMonnies' group, which will give a most brilliant centre in white to the parkling colors on either side.

Everything has been made to bend to the artistic effect, and even the shape of the lips of the basin has been one of deep and earnest thought and discussion. Nor was the position of the fountains decided upon at once, for the present location is the third to which they have been assigned.

While the mechanical and electrical arrangement fell solely to the lot of Mr. Stieringer, who, through his connection in the same line with Mr. Wiman at Staten Island, was most fully equipped for the task, the artistic features were decided upon only after repeated consultations with those whose tastes and positions in the artistic world have given their opinions the weight of authority. In conclusion it is only necessary to say what all have been led to expect, that this, perhaps, the most beautiful feature of the coming exposition, has been most nobly planned and the laurels that will be theirs will be a crown of glory well fitted for deserving heads.

A GROUP IN THE McMONNIES FOUNTAIN.

Reversibility of Threephase Motors with Inductive Winding.

BY ERNST DANIELSON.

One of the most interesting electrical machines of today is certainly the threephase motor with inductive winding. A feature of this motor, which I believe has not yet been pointed out, is that it can also be used as a generator exciting its own field. This experiment has just now successfully been carried out in the works of Allmaenna Svenska Elecktriska Aktiebolaget, in Westeras, Sweden (The General Swedish Electric Company).

The experiment was arranged as follows: A threephaser A of 50 volts (as measured from the neutral point to each of the brushes), and with a current capacity of about 60 amperes, sent current to a motor B, with inductive winding of about the same capacity. The construction of the motor was substantially the same as that of Brown, described in The Electrical World, Nov. 7, 1891. The motor, by means of a belt, ran a continuous current dynamo, C, of 330 volts and 16 amperes. Then matters were reversed so that dynamo C, fed from a 330-volt circuit, ran the motor B as a generator, sending a rotary current to the threephaser A, which then became a motor. The belt was then thrown off of A, and trials were made to break it out of step with the current, but without success. The break used was simply a lever made of wood and acting on the pulley. With these poor facilities, of course, no real measurement of the horse power could be made, but at all events, the torque was considerable.

The explanation of the possibility of such a motor to act as a generator is this:

From theory and experiment it is known that when two attractions (single phasers or multiphasers) are working synchronously, one as a generator and the other as a motor, the phase of the current lags behind the E. M. F. of the motor, whereas it is in advance of that of the generator. The result of this is that the current weakens the motor field and strengthens that of the generator. The action of the inductive threephase motor, as a generator, then, is this: The armature current induces magnetic lines in the field, and these lines, by means of the closed circuit winding, are prevented from changing their position very rapidly in the iron, and, therefore, they must rotate with nearly the same speed as the rotation takes place. Now, this field is capable of maintaining the current, provided the conditions in the external circuit are such that the current comes in advance of the induced E. M. F. These conditions can be fulfilled by having a regular threephase generator in circuit, or by condensers. It would be impossible to have the motor act as a generator on a regular lamp circuit, or a circuit with self-induction. Experiments also showed this: Resistance boxes were connected between the leads joining the threephaser and the motor. When the motor B ran as a generator it accordingly sent current not only to the threephaser A, but also to the three resistance boxes. When the threephaser was switched off the motor B immediately stopped generating.

Westeras, Sweden, December, 1892.

"Electrical Needs of the Times."

BY H. FRANKLIN WAITS.

In The Electrical World of Dec. 3 and 17, 1892, appeared two articles under the above head, in which the present writer pointed out at considerable length some of the advantages to the central station that would result from a reduction in alternating frequencies to 35 periods, or one-fourth of the present rate.

These remarks were made entirely from the standpoint of the central station, and partook more of the nature of an informal discussion than of any scientific treatment of the subject. While dealing almost wholly with the relations of engine, dynamo and belt speeds, sizes of pulleys, number of poles, etc., it was also mentioned incidentally that a variation in frequency within certain limits might make no difference in the efficiency of the transformers or their output, provided they contained a large mass of iron, etc.

In The Electrical World of Jan. 7, 1893, Mr. Louis T. Robinson, after reading through the entire series occupying not less than five columns, singles out this last paragraph as particularly favorable for his purpose, takes exception to it, and proceeds to show by figures and a perfectly sound process of reasoning, that a reduction in frequency will produce great changes in both efficiency and capacity.

Mr. Robinson must remember that I was careful not to say that a reduction of frequency would make no difference; in fact, I believe there would be some variation, but the change would be less than he evidently supposes.

But let Mr. Robinson continue his calculations and give us the results of a change in frequency from 133 to 60 periods. On the same basis as before, this would, without doubt, show great discrepancies in efficiency and output in favor of the higher frequency, and when he has completed his deductions and pronounced the lower frequency impractical and out of the question, I will inform him that the reduction above referred to makes no difference whatever in the practical results to the station with their not over sensitive instruments for power measurement.

It was in view of this fact that the writer made the statement that by having plenty of iron it might be possible to still further reduce the frequency and maintain the same general results in the transformers. My remark was, of course, purely theoretical, but based on fact, while Mr. Robinson's was also theoretical, but based on figures, and, after reading it, I do not see that we are any wiser than at the start. In all probability no man has ever experimented or made tests at so low a frequency as 35 periods, and until such tests have been made and put on record, all remarks pertaining thereto must necessarily be problematical.

But aside from all that has been said, and on general principles, is it right to give the transformers all of the pie, while the central station is compelled to subsist on crusts and stale bread, so to speak? Is it right to deliberately throw away every feature of value (between the cylinder and the armature), tending to reliability, station economy and uninterrupted service for the sake of obtaining a smaller, cheaper or more efficient transformer?

Is the lower first cost of the transformers and their higher efficiency warranted by the expense in maintaining the high frequency?

The records of many alternating plants have proved that the wear and tear to steam and electric machinery attending these high frequencies is no small item in the general expenses, and has, in fact, cost more than any reasonable consideration of transformer efficiencies resulting from at least half of the present rate or frequency.

It seems a good deal like walking across the Brooklyn Bridge to save a three-cent fare, in which the saving effected will hardly pay for the physical energy expended.

Is it in keeping with the development of the direct-current central station, as designed by such men as C. J. Field, who has given this subject the result of many years of experience in both standard and electrical engineering—I say is it in keeping with the best modern practice to run engines at speeds which the builders themselves prohibit (not in all cases, however)—to employ frequencies (133) that can never be obtained by direct driven machines, and whose very frequency forbids multiple arcing, which is of the highest value to the station, and which reduces the certainty of operation to that of a single unit—machines which are necessarily separate exciting and which increases switchboard complications—all to benefit the transformers in cost, efficiency and capacity?

Do not these high frequencies come high then? Is it not largely a one-sided question after all?

In the best plants of to-day reliability ranks first in importance and economy second.

Now frequency affects the reliability of the station apparatus more than the economy of the transformers or the net economy of the plant, taken altogether. Frequency, therefore, in its relation to reliability, should be the first consideration, but in most plants it looks as if the frequency which will most benefit the transformer was the sole factor in the entire plant, since everything else is made to conform to it.

To the station superintendent who is responsible for the continuous running of the plant, it is hard to reconcile the fact that the inert transformers which apparently take no part or interest in the proceedings are directly responsible for the high speed at which he has to run his machines, which is so difficult to obtain and still more difficult to maintain.

If we wish to obtain a physical picture that will represent (in an exaggerated manner) the relations of the transformers to certain station men that are known to the writer, and in their own way of expressing it, we would have something like this. The "dynamo man," standing with sleeves rolled up, in the doorway of the station and looking up to two transformers on top of a pole, and soliloquizing thus: "What a soft snap you fellows are having up there all to yourselves—nothing to do for three-quarters of the time but sit up there, hum and keep warm, and when you do make believe work, you don't move hand or foot, but sit up there and hum just the same, while I down here have to scratch and fly round all night long just to keep you warm so you won't go to sleep, freeze to death and fall off, and you not doing so much as one watt to pay me for my trouble. Where would you be if I should shut down for a minute? If I had my way, you would do part of the hustling."

Unfortunately, however, the electrical engineer, who decides what frequency shall be employed, is more concerned with the performance of the transformers than the speeds of the armature or engine, the diameter of the pulley or the number of poles, while the station manager who fully realizes that he "can better afford to throw a 60-h. p. engine into the scrap heap than shut down his plant for half an hour" probably takes an opposite view of the matter. The trouble is somewhere between the two extremes.

Why, then, is it not fair to decide upon a frequency that will benefit converter and station alike, so far as we are able to ascertain with our limited data? If this is done it will most likely result in a frequency between 35, as proposed by the writer, and 60, the present rate of the Westinghouse new machines. This brings us very near to 50 periods, which is the periodicity employed by Siemens and Halske, and which gives good results in practice.

Now, with the permission of the editors of The Electrical World, the writer wishes to invite station managers and superintendents, and all persons concerned with the distribution of alternating currents, to contribute to this paper their views and opinions as to the result of their experience, whether they favor an increase or decrease in frequency, and why. Let them state the present rate employed and all data, such as size of engine, speed of engine and dynamo, size of pulleys on both, and the practical results in dollars and cents to the station. A collection of such facts would be interesting as throwing some light on a subject about which the widest differences of opinion exist.

The Canadian Electrical Association.

The convention of this association will be held at the School of Practical Science, on the University Grounds, Queens Park, Toronto, on Wednesday and Thursday, Jan. 25 and 26, 1893. The offices of the association during the convention will be at No. 40 York street, near the Union station. The following is the order of business:

Wednesday, Jan. 25, 2 P. M.—President's address, secretary-treasurer's reports; reports of the committees; paper by Mr George Black, of Hamilton, on "Electrical Measurements;" paper by Mr. W. A. Tower, Toronto, on "Underground Construction." An invitation is extended to members of the association to visit and inspect the Toronto Electric Light Company's new station. 8 P. M.—Dinner at McConkey's.

Thursday, Jan. 26, 10 A. M.—Discussion on proposed amendments to the constitution; paper by Mr. P. P. Campbell, of Kingston, on "Free Wiring;" paper by Mr. R G. Black, Hamilton, on the "Incandescent Lamp;" paper by Prof. Rosebrugh, School of Practical Science, on "Speed Control;" paper by Mr. E. Carl Breithaupt, Berlin, Ont., on "Probabilities as to the Success of Distribution of Power at Considerable Distances by High-Tension Currents of Electricity." The members are invited to visit and inspect the Bell telephone's new exchange.

Experiments on the Conductivity of Insulating Bodies.*

BY M. EDOUARD BRANLY, M. D.

Insulating bodies in a very thin layer seem apt to become conducting, and their conductivity presents some peculiar characters, an idea of which is given by the following experiment:

Form a circuit containing a Daniell cell, an ordinary galvanometer, and fine metallic filings contained in a tube of glass or ebonite, between two metallic rods acting as electrodes. The file dust opposes to the current of the Daniell cell an enormous resistance, often over ten million ohms, so that the needle of the galvanometer remains in equilibrium at zero.

The thing being thus, if one produces in that circuit a sudden displacement of electricity at high potential, whether by exciting at a distance a spark of a Leyden jar, or simply by putting for a few moments a point of the circuit in contact with one of the poles of a battery of one or two hundred cells, the file dust will easily convey the current of the Daniell cell; its resistance is lowered to some hundred ohms or even less, and such conductivity persists during many hours, or even many days. It is immediately and completely suppressed by a very slight shock on the tube containing the filings.

In order to show that the shock has not suppressed the conductivity by a modification in the relative positions of the molecules, one may take instead of the tube with metallic filings another tube containing a carefully made mixture of resin and metallic dust, in proper proportions, amalgamated at the temperature of fusion of the resin.

Such a mixture, pasty when hot, becomes solid and extremely hard when cold. Such a tube, which presents an infinite resistance to the current of a single Daniell cell, becomes conducting under the same circumstances as the metallic dust with intervals of air; and its conductivity disappears also under a slight shock. You may thus reproduce and suppress it alternately as often as you wish. These experiments may be diversified in a great number of ways.

NEW BOOKS.

The Mining Directory and Reference Book of the United States, Canada and Mexico. By Geo. W. Ramage. 351 pages. Chicago: Poole Brothers. 1892. Price, $10.

This valuable work contains lists of mining and quarrying companies and operators, smelters, reduction and sampling works and blast furnaces, giving the location of same, names of officers, annual output, etc, as well as a very complete list of mining engineers, assayers, metallurgists, inspectors and others interested in mining operations. A feature of the book is the elaborate system of compilation, showing at a glance the most complete information obtainable regarding mining plants throughout the country. It also contains digests of mining statutes and codes of the different mining countries, the railway and water routes to all points where mines are located, and the nearest shipping and express point. This is the first volume of the book, which will be published annually hereafter.

How to Make and Use Induction Coils. By Edward Trevert. 81 pp., 36 ills. Lynn, Mass: Bubier Publishing Company, 1892. Price 50 cents.

This little book gives details and directions regarding the construction of an induction coil and the management of certain experiments that may be made with it. Some directions are also given regarding the batteries best suited to operate induction coils for experimental work.

*From the *Philosophical Magazine*.

Recent Progress in the Introduction of the Triphase System.

The fact that so little has been published lately regarding the triphase alternating current system appears to have led to the belief in this country that the great expectations entertained regarding it at the time of the Lauffen-Frankfort transmission were not being realized, and that its introduction at that time was soon followed by its abandonment. But this is by no means the case. Its introduction is at present limited to the European countries, where developments, according to our American views, are comparatively slow, but at the same time they are sure, mistakes in matters of that kind being seldom made there.

Recent reports from Berlin show that the triphase system is being perfected in its details by Mr. Dobrowolsky, and that the introduction of some very large plants are being considered, if not already contracted for. The motors have been simplified to such a degree that they are now already much cheaper than the continuous current motors, besides being unquestionably far superior to them in flexibility and simplicity of operation. The armatures, if they can be called so, even of the 100 h. p. motors, are now made simply of a series of iron discs, through which copper bars are run, the ends of all of which are riveted to copper discs, so at each end making a simple short-circuit winding. This cheap and simple method was formerly used only with small fan motors and was described in The Electrical World Oct. 31, 1891, p. 319, but it is now applied to all sizes. There is, therefore, neither commutator nor even collector ring, there being no sliding contacts whatsoever. Greater simplicity could hardly be desired.

Mr. Emil Kolben, the electrician of the Oerlikon Company, in a recent number of "Industries," published the following table of data of the standard triphase current motors built by that company, the development of which is carried on conjointly by this firm and the one in Berlin.

TABLE GIVING RESULTS OF TESTS OF SIX SIZES OF STANDARD TRIPHASE MOTORS.

Nominal size in horse power...	¼	⅛	½	3	6	9
Frequency	50	50	50	50	50	50
Rev. per min. no load	1,450	1,450	1,450	1,475	975	970
" " " full load	1,320	1,335	1,350	1,380	930	900
Max. starting torque in lb.-ft..	2.25	2.85	7.1	11.6	70	82
Full load torque in lb.-ft	.91	1.82	5.5	10.7	32.4	49
E. M. F. bet. terminals and neutral load	60.5	60	57	63	61	67
Current in each branch at no load.....	1 3	4	7	7.5	20	25
Current in each branch loaded	2.5	8	13.8	18	59	86
Power in watts required at no load.....	105	..	346	404	....	....
Power in watts required when loaded	325	670	1,900	2,940	6,620	10,400
Output delivered at pulley during duration test of four hours, in horse power.....	0.23	0.49	1.5	3.0	7.1	11.5
Output delivered at pulley during duration test of four hours, in watts	170	368	1,104	2,208	5,300	8,600
Commercial efficiency in per cent.....	52	55	60	75	80	83
Total weight of motor in pounds..... ...	93	176	220	330	610	940

In reply to a remark recently made by Mr. Rankin Kennedy in an English journal, in which he asks whether triphase current motors are "any good, anyhow," Mr. Kolben published this table, and adds the following:

"They start under full torque, even when heavily overloaded, and have a moderate exciting current. Their

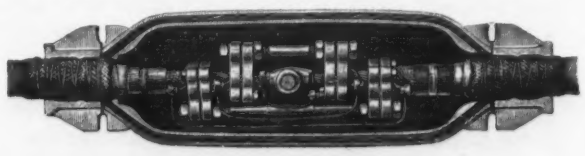


FIG. 5.—JUNCTION OF MAINS.

efficiency is as high as that of any continuous current motor of equal size in the market, and their speed is nearly constant under varying loads, like that of a good shunt motor. With a frequency of 45 to 50 periods per second, which is also quite high enough for good arc and incandescent lighting, the actual losses when running light are small, and the motors produce no undue "drop" on a transformer well proportioned for motor work.

"A large number of theoretical investigations and considerations have been written showing how multiphase motors would and should work, if they were made this, that or some other way; and why they do not work satisfactorily; and why they cannot work at all. But, as far as I know, few facts have been published about their actual performance. In the above table are given the results of tests of six sizes of standard Oerlikon triple current motors. These motors have a uniform triple ring winding outside, and a short-circuit winding inside. The maximum starting torque was determined by winding a flat rope round the pulley, attaching its lower end to the floor, and its upper end to a crane above, through a well-calibrated spring balance. The results were checked by ordinary Prony brakes. The tests on larger sizes have not yet been completed, but there is every reason to believe that the results will be at least as good as those given above. A glance at the table will show that the triple-circuit motors are commercial machines, and that they can successfully stand the competition of any electric motor."

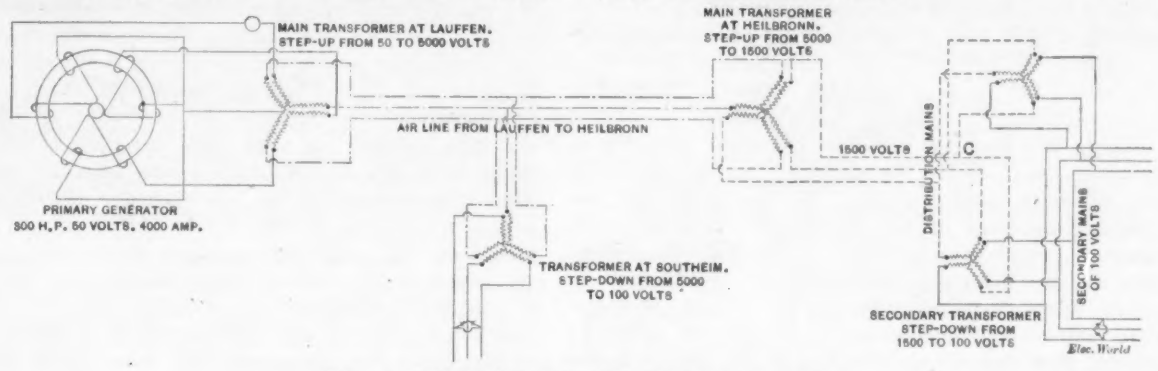

MAIN TRANSFORMER AT LAUFFEN. STEP-UP FROM 50 TO 5000 VOLTS
MAIN TRANSFORMER AT HEILBRONN. STEP-UP FROM 5000 TO 1500 VOLTS
AIR LINE FROM LAUFFEN TO HEILBRONN
1500 VOLTS
DISTRIBUTION MAINS
C
PRIMARY GENERATOR 300 H.P. 50 VOLTS. 4000 AMP.
TRANSFORMER AT SOUTHEIM. STEP-DOWN FROM 5000 TO 100 VOLTS
SECONDARY MAINS OF 100 VOLTS
SECONDARY TRANSFORMER STEP-DOWN FROM 1500 TO 100 VOLTS
Elec. World

FIG. 1.—DIAGRAM OF HEILBRONN PLANT.

Mr. Brown, who was formerly the electrician of that company, is also introducing three-phase motors, as appears from a recent report that his firm is about to introduce a triphase system at the city of Novorossik, on the Black Sea. The plant is intended for loading ships with grain. The installation consists of four steam engines of 250 h. p., coupled directly with dynamos of 300 h. p., probably of the same design as the one used at Lauffen, of which we published a full description in our issue of Aug. 22, 1891, p. 126. The voltage to be used is 230; the power is to be distributed among 60 different motors, varying from 10 to 20 h. p. It is a

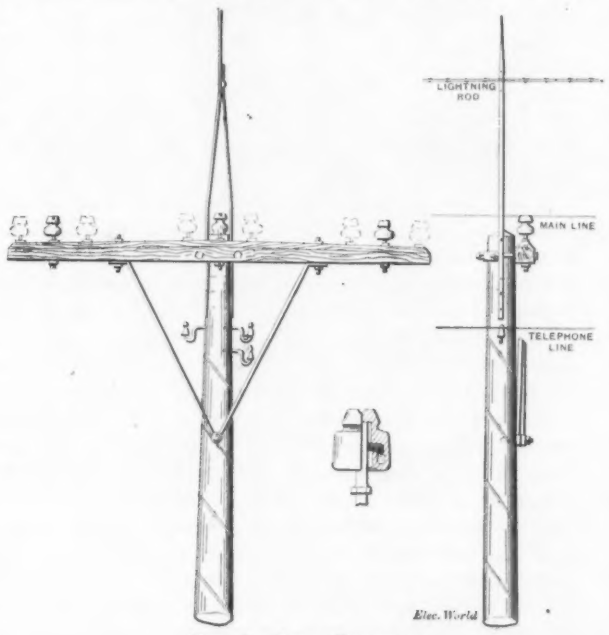


FIG. 3.—LINE SUPPORT.

system of distribution, rather than one for long distance transmission, as the distance to the farthest motor is only three-fourths of a mile.

Besides this installation in Russia there is a 300 h. p. plant being erected at Hartford, in this country, by the Thomson-Houston Company; the Niagara Falls Power Company, is, furthermore, considering the introduction of at least one 5,000 h. p. generator for three-phase currents.

The only central station running at present in which three-phase currents are used exclusively for both light and power is that at Heilbronn, to which we have referred briefly a number of times in these columns. We have recently received from Mr. Oscar V. Miller, who designed and erected the plant, a more complete description of this plant, from which we take the following abstract and illustrations:

The power is generated at the town of Lauffen by the same machines and turbines which were used in the now famous Lauffen-Frankfort transmission. The currents are transmitted to the town of Heilbronn, about six miles distant. A diagrammatic representation of the system is shown in Fig. 1, which will explain itself. It will be noticed that the current is generated at 50 volts, then transformed up to 5,000, at which it is transmitted; at the outskirts of the city of Heilbronn it is transformed down to 1,500, at which it is distributed to sub-stations throughout the city. At or near the places of consumption it is further transformed down to 100 volts, at which it is distributed throughout the city by means of a single system of interconnected mains. At about half way between the two cities a branch line is run to supply street light in the small town of Southheim.

The plant at presents consists of two generators and turbines of 300 h. p., one of which represents reserved power. The losses in the line are 10 per cent. for the long distance line, 2 per cent. for the 1,500 volt lines and 1½ per cent. for the distribution mains. The current generated by the dynamo is 4,000 amperes at 50 volts. The fall of water at the generating station is about 12 feet; the turbines are of 330 h. p.; their speed is kept constant by a hand regulator at about 35 revolutions per minute.

When the full capacity of the dynamo is not required at Heilbronn, the spare current is used for drying purposes at the cement factory, immediately joining the generating station, thereby replacing an expensive heating ar-

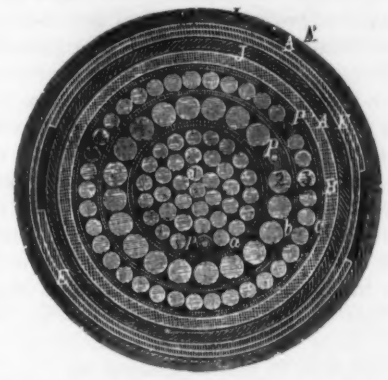


FIG. 4.—CROSS-SECTION OF MAINS

rangement in which thousands of tons of coal were formerly used. It also serves to keep the speed of the turbine constant.

The secondary transformers used at Heilbronn for converting from 1,500 down to 100 volts have a capacity of from five to ten kilowatts. They are placed in metallic cases shown in Fig. 2, which are situated on the sidewalks. All the connections, switches, etc., are contained in these cases and are very readily accessible.

The long distance line consists of three bare copper wires six millimetres in diameter (slightly larger than a No. 3 B. & S. wire), running on oil insulators supported on wooden columns, as shown in Fig. 3. The latter are from 25 to 50 feet in height, and are placed at about 125 feet intervals. They are designed to hold nine wires, as shown, but at present only three are in use. Each pole terminates in a lightning rod connected to the ground by means of a spirally wound barbed wire, which serves the double purpose of ground connection and a safeguard to prevent people from climbing the poles. About three feet below the high tension lines there are three hard drawn copper wires of 1½ millimetres, which serve for testing purposes and for telegraphic transmission between the two cities.

At present there are about five miles of streets in which the mains are laid. A cross section of these mains is shown in Fig. 4 and a junction in Fig. 5. As will be seen, the cable consists of three concentric conductors made of wires, one of which in each layer is insulated, for testing purposes.

One of the most interesting parts of the plant is the use of three-phase motors for general power distributing purposes, and it is reported that their success has come quite up to the expectations. Their simplicity enables them to be introduced where motors requiring more attention would be objectionable. The only attention they require is to be supplied with lubricating oil every week or ten days. Their cheapness has enabled them to be introduced in a number of factories. The motors are guaranteed by the makers to consume no more than 500 watts per horse power.

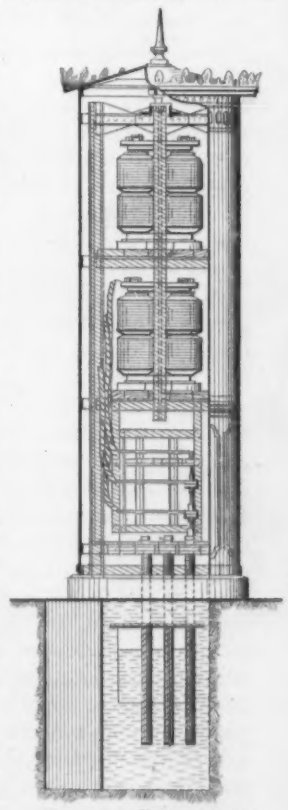


FIG. 2.—SECONDARY TRANSFORMER.

The charges made for current at Heilbronn are as follows: For 100 watt hours, 7½ pfennigs, or very nearly 3 cents. For power, heating and electro-metallurgy this is reduced to three pfennigs, of about 1.2 cents. Besides this there is an increasing reduction for motors running for a certain number of hours, which for 2,000 hours is 20 per cent. It is proposed to charge at the rate of about 25 cents per horse power per day for motors which are run regularly.

The cost of the installation was about $65,000. At present there are in use 1,700 incandescent lamps, 20 arcs and 11 motors, having a total of 32 h. p.

Werner Von Siemens: Some Additional Details Regarding His Life and Work.

(From our Special Correspondent.)

It has been said that great men are not the children of one nation; they are the sons of the world. The scientist is the true cosmopolitan. His labors are not confined, like those of the statesman or the soldier, to the advancement of one community or one country—they are wider, more catholic, in their reach. And the honor of belonging to the ranks of these heroes of science will be accorded to no one more generally or more deservedly than to Werner von Siemens.

Siemens was born on Dec. 13, 1816, at Lenthe, near Hanover. He early developed an ardent love for mathematics, and spent all his leisure in the pursuit of his favorite study. He was destined to become an architect; but his father, a tenant on a large estate in the country, was unable to provide the means necessary for a proper course of study at the School of Architecture. In this difficulty Siemens was helped by the friendly and opportune advice of one of his tutors, under whom he was learning land measuring and surveying—a lieutenant in the Luebeck Contingent, who had formerly served in the Prussian Artillery—who urged Siemens to enter the Prussian Engineer Corps, where he would be instructed in all that was taught at the School of Architecture and at much less expense. In 1834 Siemens accordingly enlisted in the Prussian Engineer Corps in Magdeburg. In the autumn of 1840 he was ordered as an officer to Wittenberg. Here he became acquainted with Jacobi's invention relative to the deposition of copper in metallic form from a solution of copper vitriol by means of the galvanic current. This greatly interested him, and he began himself to experiment with the deposition of other metals; owing, however, to want of adequate means and arrangements, his efforts were attended with little or no success.

A circumstance occurred here which in its consequences altered somewhat materially the course of Siemens' life. He acted as second in a duel between two young army officers; and at that time the Prussian laws against dueling were exceedingly severe, and for this reason, perhaps, the sentences passed on delinquents were almost invariably lightened by early pardon. Although the affair with which Siemens was connected had no fatal result, he was sentenced to five years' confinement in the fortress of Magdeburg. The principals, it may be mentioned, were sentenced to ten years. The thought of being condemned to durance vile for a period of some six or seven months—the pardon was generally expected within about that time—was naturally anything but welcome to Siemens; he consoled himself, however, with the reflection that he would have ample opportunity for study. He managed by dint of a little diplomacy to smuggle into his quarters some chemicals and other requisites, with which he improvised a little laboratory, where he continued his experiments. His efforts were now crowned with more than looked for success. Some observations which he had made in connection with the Daguerreotype process, which had become known a short time earlier, led him to inquire into the possibility of employing solutions of gold and silver salts for electrolytic purposes. Siemens describes it in his "Lebenserinnerungen" as one of the happiest moments of his life when he beheld a common german-silver spoon transformed within a few minutes into a glittering gold spoon, after attaching it to the zinc pole of a Daniell cell and suspending it in a glass containing a solution of hyposulphate of gold, while a louis d'or was attached as the anode to the copper pole. The art of gold and silver plating by means of the galvanic current was entirely new at that time—in Germany, at least—so that Siemens' success created an immense sensation among his comrades and acquaintances. He arranged to sell the right to use his process to a jeweler in Magdeburg for the magnificent consideration of forty louis d'or, which enabled him to prosecute his researches further. He had hardly passed five weeks in the fortress of Magdeburg before he was pardoned. Siemens, however, received the news of his pardon with more disappointment than relief; he had become attached to his sanctum and his experiments were beginning to be successful; and to be thus ruthlessly dragged from his studies was a circumstance he was not prepared for. He petitioned to be allowed to prolong his stay, so that he might complete some experiments. The result was not happy, for the request was regarded in the light of an expression of contempt for the royal pardon. Siemens was awakened in his cell at midnight by the entrance of the officer of the guard, who, armed with the authority of a Cabinet order, desired him immediately to quit the fortress. Instead of returning to Wittenberg, Siemens was ordered to Spandau, and shortly afterward to Berlin for service in the artillery workshops.

Siemens had obtained a Prussian patent for five years on his electrolytic process, which he had worked out thoroughly while in Magdeburg, and on coming to Berlin he concluded an arrangement with a german-silver factory for carrying on gold and silver plating on the basis of his patent. This was the first establishment of the kind in Germany. Siemens' brother Wilhelm— the late Sir William Siemens—who had been educated as an engineer, assisted him in this work; and they afterward arranged between them that Wilhelm should go to England and try and dispose of the English patent. He succeeded in selling it for £1,500 sterling to a Mr. Elkington, who had himself for some time previously been engaged in electrolytic work on the basis of a similar process. The acquisition of this sum put an end for a time to Siemens' pecuniary difficulties, which greatly hindered him in his work, and his position as an officer in the army prevented his doing much in a business way.

While on furlough Siemens visited his brother in London in connection with two further patents which he had taken out relative to nickel plating and zincography. On his way back he visited the exhibition in Paris. Returning again to Berlin, he devoted himself earnestly to scientific study and gave up his other interests entirely. A number of men who have since become famous in science were colleagues of Siemens at this time, and were associated with him in the founding and development of the Physical Society; among these may be mentioned the names of Du Bois-Reymond, Bruecke, Helmholtz, Clausius, Wiedemann, Beetz, and Knoblauch.

Among the scientific technical questions with which Siemens then occupied himself was that of employing hot air as a motive power. In the year 1845 he published an essay on the subject with a sketch of a proposed hot-air machine and describing its theory. This was based on the principle of the conservation of energy, first enunciated by Robert von Mayer and afterward mathematically developed by Helmholtz. A further problem that engaged his attention at this time was the utilization of the electric spark to the measurement of speed. Following this line of thought Siemens conceived the idea of measuring the speed of the electric current itself in a conductor by the same method.

Having had an opportunity of seeing at the house of a friend a Wheatstone needle telegraph instrument, Siemens began to interest himself in the question of the substitution of electric telegraphy for optical telegraphy. He devised a more perfect form of needle telegraph instrument by the introduction of the automatic contact brake. He intrusted the mechanical part of his apparatus to Halske, a young mechanic with whom he had become acquainted in the Physical Society, and who at that time had a small mechanical workshop under the style of Boettcher & Halske.

This was the first step toward Siemens' later great practical activity, with its long train of successes and achievements that have made his name inseparable from the development of the electric telegraph, and was the inception of the now world-famed firm of Siemens & Halske.

It was on the 12th of October, 1847, that Siemens established in company with Halske the little workshop in the Schoeneberger Strasse in Berlin that has since developed into the great and world-famed firm of Siemens & Halske, with its branches in many of the capital cities of Europe and its latest offshoot in America, where, if report be true, it bids fair to take a leading place among the large electrical industries of the United States.

Siemens had been called to serve on a special commission appointed by the military authorities for the purpose of arranging for the introduction of the electric telegraph in place of the optical telegraphs then in use, and he was not willing to give up his official position until the commission had completed its labors and some definite arrangement had been arrived at regarding the future of the government telegraph system. A period of great political excitement ensued, which saw its climax in the revolution of March 18, 1848, in Berlin. In the excitement all serious business questions were forgotten, and the whole government machinery stopped. The telegraph commission too was obliged to suspend its work. It was due alone to the untiring energy of Halske that the little factory that had only just been started continued its steady quiet work despite the unfortunate conditions of the times and the fact that no orders at all were coming in. Siemens himself was in an embarrassing situation; his official work was in abeyance for an indefinite time, and in the face of an impending war with Denmark it was impossible for him to think of leaving the army. At this juncture, as oftentimes before in his life in a similar way, circumstances intervened which opened up to him a new and favorable channel for further activity and usefulness. The encroachments of the Danish influence in Schleswig-Holstein had embittered the relations between Prussia and Denmark, and an outbreak of hostilities between the two countries became imminent. Learning from his brother-in-law Himly, who was professor of chemistry at Kiel, of the threatened bombardment of the town by the Danish fleet, Siemens conceived the idea of laying submarine mines and igniting them from the shore by means of electricity. He submitted the proposal to Himly, who took the matter up with the government, with the result that when war was declared Siemens was sent to Kiel to carry out the work. The mines did not, it is true, come into actual operation; but they were the means of keeping the enemy's ships out of German waters.

During the peace negotiations Siemens returned to Berlin, and was soon afterward commissioned by the government to lay the underground telegraph line between Berlin and Frankfort-on-Main. In the early days of telegraphy it was generally thought than an overhead and easily accessible line would not answer, as it was feared that it would be tampered with by an inquisitive public or a political mob; wherever, therefore, it was proposed to introduce the electric telegraph on the continent of Europe trials were invariably made in the first instance with underground lines. The success of these was, of course, limited, owing to the imperfect insulation. Siemens' brother Wilhelm happened to send him over from London as a curiosity a piece of gutta-percha, which had just been put upon the English market as a new insulating material. The extraordinary properties of this composition as a dielectric attracted Siemens' attention, and the success of some experiments which he made with wires covered with the gutta-percha when in a plastic state assured him of the value of the discovery. At first the wire was covered with the gutta-percha by means of rollers, but it was found that the seam made by the rollers gave way in time, rendering the wires useless. Siemens then devised a screw press with which, by the application of high pressure, he succeeded in covering the wire without any seam with the gutta-percha, the latter being first reduced to a plastic state by heating. The wires covered in this way with the aid of an improved screw press constructed by Halske proved to be well insulated, and were found to retain their insulation permanently. For the better protection of the wires on the Berlin-Frankfort line Siemens proposed to surround them with a casing of iron wire or to inclose them in iron pipes, but the proposition was not entertained owing to the great cost. Halske had devised a galvanometer much more sensitive than anything then in use for testing the lines that were being made in the factory of Fonrobert & Pruckner, in Berlin, and during some of these tests Siemens observed the phenomenon of the electrostatic charge in circuits submerged in water. He also devised a method of localizing faults in long lines.

The following year, 1848, was one of marked interest and busy employment for Siemens. While working on the Berlin-Frankfort line his attention was attracted again to electrostatic induction; and its detrimental effects upon the working of the same gave him much trouble. After careful study Siemens succeeded in satisfactorily explaining the phenomenon and overcoming the difficulties which it introduced. In the winter of 1849 Siemens had the satisfaction of seeing Berlin in telegraphic communication with the city of the Main. The success of this, the first long-distance telegraph line not only in Germany, but in all Europe, made it the precursor of further long lines, notably those between Berlin and Cologne and Verviers. Siemens was also intrusted with this work.

An incident happened in connection with the construction of the line between Cologne and Verviers which, in its relation to the history of one of the immediate results of the development of telegraphy, is of more than passing interest. Siemens became acquainted with the proprietor of the carrier-pigeon post between Cologne and Brussels, one Reuter, whose business had been sadly damaged by the introduction of the electric telegraph; and, upon the latter complaining of the altered conditions and the disastrous effect it had upon his business, Siemens advised him to go to London and establish a telegram agency on similar lines to that which had just been founded in Berlin by a relative of his through a Mr. Wolff. Reuter acted upon this advice, as people will do sometimes, and met with extraordinary success. Reuter's Telegram Agency is now an organization known all over the civilized world. Critically taken, Siemens may be regarded as the originator of the modern telegram agency, which has become a medium of vast importance nowadays in the production of the daily newspaper—that sine qua non of nineteenth century civilization.

In the mean time the little workshop, under Halske's able management and owing to its already important achievements, had become widely known and recognized. In 1849 Siemens retired from the army and government service to devote himself entirely to the practical development of telegraphy and the solution of the scientific and technical problems which each day's work brought with it. Halske, it may be mentioned, gave up his personal interest in the business as early as 1867.

Between 1852 and 1856 Siemens was engaged in the construction of a network of telegraphs for the Russian government. His experiences in the land of the Czar are well narrated in his "Lebenserinnerungen," and form a vivid picture of the conditions prevailing in that country at a time when the principle of absolutism and the evils of a none too scrupulous bureaucracy were strongly reflected in the national life and character of the people.

Then followed the laying of Siemens' first deep-sea cable between Bona, in Algiers, and the island of Sardinia. In 1859 the Red Sea cable was laid. In 1869 Siemens proposed a direct telegraph line between England and India, which was carried into execution in the following year and exists to-day as the Indo-European telegraph line.

Berlin, Dec. 16, 1892.

Chronological History of Electricity—Part II.—1800-1820.

BY P. F. MOTTELAY.

ITSCHERLICH (Eilard-Eilhert), professor of chemistry at the Berlin University, discovers what is called *Isomorphism* (*isos*, equal; *morphe*, form), showing that bodies containing very different electro-positive elements could not be distinguished from each other; it was impossible therefore to put them in distant portions of the classification, and thus, remarks Whewell, the first system of Berzelius crumbled to pieces.

In other words, Mitscherlich was the first to draw attention to the fact that two bodies having the same composition could assume different forms; to this law Berzelius gave the name of *Isomerism* (*isos*, equal; *meros*, part).

Sir John Herschell makes particular mention ("Treatise on Light," sec. 1,113) of Mitscherlich's remarkable experiment with sulphate of lime—the alteration in the tints of which by heat, it is said, was first observed by Fresnel. This experiment was repeated by Sir David Brewster, and he discovered still more curious properties in *glauberite*, all of which are detailed in vol. 1, page 417, of the *London and Edinburgh Phil. Mag.* for Dec., 1832.[1]

A. D. 1820.——Ampère (André Marie), one of the most distinguished philosophers of this century (1775–1836), professor of mathematical analysis in the French Ecole Polytechnique (1809), afterwards professor of physics at the Collège de France, read before the Académie Royale des Sciences, Sept. 18, 25, Oct. 9, 13, and Nov. 6, 1820, papers containing a complete exposition of the phenomena of electro-dynamics. His investigations were subsequently embodied in the "Recueil d'Observations. . . ," Paris, 1822, and were still further developed during 1824 and 1826, as shown through his "Précis de la théorie . . ." and "Théorie des Phénomènes Electro-Dynamiques."

The news of Oersted's discovery of the relation existing between the electric current and the magnet—the fundamental fact of electro-magnetism—was made known in July, 1820, and the inquiry was at once taken up more particularly by Ampère, Arago, Biot, Savart and Savary in France, as well as by Berzelius, Davy, De la Rive, Cumming, Faraday, Joseph Henry, Schweigger, Seebeck, Stugeon, Nobili and others throughout Europe and elsewhere. Of all these scientists, Ampère proved the most energetic, and, within three months of the announcement of Oersted's discovery, his first memoir on the subject was publicly read in Paris.

In this first paper, Sept. 18, he explains the law determining the position of the magnetic needle in relation to the electric current, and, by way of illustration, he proposes that a man should imagine himself at full length, and the current to be transmitted through his body, the positive wire being applied to his feet and the negative wire to his head, so that the current of positive fluid shal pass upward from the feet to the head, and that of the negative fluid downward from the head to the feet. This being premised, a magnetic needle freely supported on its centre of gravity, so as to be capable of assuming any direction, and placed before him, will throw itself at right angles to him; the north pole of the needle pointing toward his left, and the south pole toward his right. He also makes known his intended experiments with spiral or helical wires, which he justly predicts will acquire and retain the properties of magnets so long as the electrical current flows through them, and he likewise explains his theory of magnets, saying that if we assume a magnet to consist of an assemblage of minute currents of electricity whirling all with the same direction of rotation around the steel molecules and in planes at right angles to the axis of the bar, we will have an hypothesis which will account for all the known properties of a magnet. Ampère constructed his spirals and helices, and to the astonishment of the scientific world made magnets formed only of spools of copper wire traversed by electric currents We can readily imagine, adds Prof. A. M. Mayer, the intense interest awakened by this discovery, a discovery which caused Arago to exclaim, "What would Newton, Halley, Dufray, Æpinus, Franklin and Coulomb have said if one had told them that the day would come when a navigator would be able to lay the course of his vessel without a magnetic needle and solely by means of electric currents?" "The vast field of physical science," says Arago, "perhaps never presented so brilliant a discovery, conceived, verified and completed with such rapidity." Thus Ampère became the author of a beautiful and comprehensive generalization, which not only included the phenomena exhibited by the new combinations of Oersted, but also disclosed forces which existed in arrangements already familiar, although they were never detected till the theory pointed out how they were to be looked for. His electro-dynamic theory of the action of currents and of magnets has been thought worthy, so far as the logic of its demonstration is concerned, of a place near the Principia of Newton . . it gained him the title of the Newton of electro-dynamics, and justly, too, as he did for this branch of science even more than Coulomb had previous done for electrostatics.[2]

The experiments of Oersted and Ampère were greatly extended by many scientists, among whom may be especially mentioned Messrs. Yelin, Brockman, Van Beek, De la Rive, Moll, Nobili, Barlow and Cumming. The last named apparently gave the earliest notice of the increased effects of a convolution of wire around the magnetic needle, and constructed the first astatic needle galvanometer.[3] The Chevalier Julius Konrad Yelin (1771–1826), German mathematician, afterwards ascertained that the electricity of an ordinary machine when passed along a helix, either in simple electrical sparks or by discharges from a battery, has the effect of rendering an included needle magnetic. According to Dr. Henry, Mr. Brockman found in varying these experiments that no modification of the effect is produced by altering the diameter of the helix from half an inch to 13 inches. With a helix of 34 inches diameter, and a coated surface of 300 square inches, much less magnetism was, however, imparted; and with one of 84 inches it was scarcely perceptible. It was found that a needle outside of the helix was magnetized as much as one within; that after being once fully magnetized a continuation of the discharges diminished its power; and that five jars, each of 300 square inches, did not produce, by repeated discharges, much more effect than one of them.[4]

In his second paper, Sept. 25,[5] Ampère makes known the results of his experiments on the mutual attractions and repulsions of electrical currents. He shows that when the voltaic current is passed in the same direction through two parallel wires, so placed as to move freely, they attract each other, and that they are repelled if the currents are passed in opposite directions. He thus establishes the second fundamental law of electro magnetism, the first law instituted, as we have seen by Oersted, being that the mag-

ANDRE MARIE AMPERE.
(After a steel engraving by Tardieu, in 1825.)

netical effect of the electrical current has a circular motion around the current. He also proposes in the last-named paper the hypothesis of currents of electricity circulating from east to west around the terrestrial globe in planes at right angles to the direction of the dipping needle, to account for the phenomena of terrestrial magnetism,[6] while in his third paper, Oct. 9, he investigates the properties of currents transmitted through wires forming closed curves (*courbes fermées*) or complete geometrical figures, an inquiry also alluded to in another memoir read Oct. 30, 1820. These papers were immediately followed by others, which engaged nearly all the sittings of the Academy between Dec. 4, 1820, and Jan. 15, 1821, and wherein he brings forth new confirmations of his theories, and reduces the phenomena of electro-magnetism to mathematical analysis.

Mr. Samuel Prime remarks[7] that the discovery of the action of the spiral coil upon the magnetic needle seems to have been independently made by Ampère in 1821:

> I showed that the current which is in the pile acts on the magnetic needle by the conjunctive wire. I described the instrument, which I proposed to construct, and, among others, the galvanic spiral. I read a note upon the electro-chemical effects of a spiral of iron wire, subjected to the action of the earth, directing an electric current as well as a magnet. I announced the new fact of the attraction and repulsion of two electric currents, without the intermediation of any magnet, a fact which I had observed in spirals twisted spirally.[8]

One of his biographers says:

> The result of these researches of Ampère may be summarized in the statement that an electric current, in a linear circuit of any form, is equivalent in its action, whether on magnets or other circuits, to a magnetic shell bounded by the circuit whose strength a every point is constant and proportional to the strength of the current.

Ampère is the inventor of the *astatic* needles, a description of which, taken from one of his memoirs (*Ann. de Ch. et de Ph.*, vol. xviii., p. 320), appears at pp. 220–281 of Fahie's "History."[9] For this greatly perfected form of galvanometer the credit has erroneously been given to Professor Cumming, who first suggested the idea of neutralizing the directive force of the needle arising from the earth's magnetism which he did by placing a magnetized needle immediately beneath the movable or index needle. Fahie adds, in a foot note: "In Professor Cumming's paper 'On the Connection of Galvanism and Magnetism,' read before the Cambridge Philosophical Society on April 2, 1821, he described a near approach to the astatic needle. In order to neutralize the terrestrial magnetism he placed a small magnetized needle under the galvanometer needle.[10] The credit of Ampère's discovery is usually attributed to Nobili, as in Noad's "Manual of Electricity," London, 1859, p. 327; also Roget's "Electro-Magnetism," in "Library of Useful Knowledge," London, 1832, p. 42.[11]

As has been already shown (Laplace, A. D. 1820), the first proposal to apply Oersted's discovery to telegraphic purposes by substituting the deflection of the magnetic needle through electric currents for the divergence of the pith balls of the electroscope, was made by Ampère, in his Memoir of Oct. 2, 1820, which appears in the *Comtes Rendus*, and at p. 72, vol. xv., of the *Annales de Chimie et Physique*. His plan, remarks Sabine, was, however doomed to the same fate as that of Sömmering, of never coming into practice, and for the same reasons, principally the number of line wires. Had Ampère combined his system, or rather that of Laplace, with that which Schweigger proposed of reducing Sömmering's telegraph to two wires, or with any other using a code of signals, the problem of the electric telegraph would have been solved from the year 1820. Ampère makes no mention of surrounding the needles with *coils of wire*, as is so frequently stated by writers on the telegraph. Indeed he could not then have even heard of the galvanometer; for, although Schweigger's paper on the subject was read at Halle on the 16th of September, 1820, it was not published until the November following.[12]

Mr. Jean Jacques Antoine Ampère (1800-1864), son of André Marie Ampère, was an accomplished scholar succeeded François Andrieux as professor at the *Collège de France* and became a member of the French Academy in 1847.

Transportation Rates to the National Electric Light Association.

The various passenger associations have granted an excursion rate of a fare and a third to delegates attending the convention of the National Electric Light Association, to be held in St. Louis, Feb. 28, March 1 and 2, 1893. To secure this rate it will be absolutely necessary for persons purchasing tickets to state to the agent from whom the purchase is made that they contemplate attending this meeting, and to procure from the agent a certificate which, immediately upon their arrival in St. Louis, should be left in the secretary's office, addressed to Mr. C. O. Baker, Jr., Master of Transportation, who will see that it is properly vised and returned to the owner.

Arrangements are now being made for a special train from New York to St. Louis, which will exceed in the way of equipment and appointments anything that has ever been in service between these two points. To bring this matter to a successful issue, it is very important that the number of passengers who wish to avail themselves of this train should be known at the earliest possible moment. Therefore, it is very desirable, and will facilitate the transportation matters greatly, if all delegates who contemplate using this train will make application for space at once to Mr. Baker, at 136 Liberty street, New York City.

---

[1] Consult the "Cat. Sci. Papers Roy. Soc.," vol. iv, pp. 413-416; "Library Useful Knowledge" (Pol. of Light), p. 63; Poggendorff, vol. ii., pp. 160, 161; the very able treatise of Mr. J. Beete Juks on Mineralogical Science; also Poggendorff's *Annalen*, vol. xv., p. 630, for Mitscherlich on the chemical origin of iron glance in volcanic masses.

[2] Profs. A. M. Mayer and W. B. Rogers, "Memorial of Jos. Henry," 1880, pp. 81, 476; Lardner, "Lectures," 1859, vol. ii., p. 120; Fahie, "Hist. El. Tel.," p. 276.

[3] "*Trans. Camb. Soc.*," vol. i., p. 279.

[4] "Poggendorff, vol. ii., p. 1,382; Gilbert's *Annalen* for 1820-1823.

[5] *Ann. de Chem. et de Phys.*, vol. xv., pp. 59-170.

[6] Roget, "Electro-Magn.," p. 47.

[7] "Life of Morse," 1875, p. 266.

[8] Tillooh's *Journal of Science*, vol. lvii., p. 47, 1821.

[9] See Knight's "Mech.' Dict.," 1874, vol. i., p. 171, and vol. ii., p. 1,181.

[10] *Trans. Cam. Phil. Soc.*, vol. i., p. 279.

[11] For accounts of Ampère's rotary magnet, electro dynamic cylinders, revolving battery, and of his electripeter employed to alter rapidly the direction of the electric current in voltaic batteries, consult pp. 639, 640, 643, vol. viii., of the Eighth "Britannica."

[12] Fahie, "Hist. of El. Tel.," p. 303. See "Catal. Sci. Papers Roy. Soc.," vol. i., pp. 58 61; Messrs. Sainte Beuve et Littre's account of his life and labors in the *Revue des Deux Mondes* for Feb. 15, 1837; "Notice sur M Ampère," *par* Mr. E. Littré, Paris, 1843; Arago's Eulègy on Ampère, translated, at pp. 111-171 of the "Report of the Smithson. Institution" for 1872. Consult also "Report Smiths. Instit." for 1857, pp. 100-107; Ampère's biography in the *Sci. Am. Suppl.*, No. 674, p. 10,760; also Ampère's "Journal et Correspondance," Poggendorff, vol. i., pp. 39, 40; Address of His Royal Highness the Duke of Sussex to the Eng. Roy. Soc., 1836; Barlow on "Magnetic Attractions"; *Comptes Rendus* for 1838, vol. vii., p. 81; *Bibl. Univ.*, xx.; *Phil. Mag.*, vols. lvi., p. 308, lvii., pp. 40-47, "On the Electro-Magnetic Experiments of Oersted and Ampère," by Mr. Hatchett, and pp. 47-49; *Ann. de Phys. de Bruxelles*, vol. vii; *Ann. de Ch. et Phys.*, xxix.; Du Moncel, vol. iii., p. 7; "Acad. de Paris," Sept. 12, 1825; *La Lum. Elect.* for Oct. 31, 1891, p. 202; Roch, in "Zeitschr. f. Mathem.," 1859, p. 295; Roget on Ampère's theory of Mag.; K. W. Knochenhauer, *Pogg. Annal.*, xxxiv., 481; J. Marsh, "On a Particular Construction of Mr. Ampère's Rotating Cylinder," *Phil. Mag.*, lix., 433, 1822; Henn, "De Amperi principiis . . . ;" W. Ritchie, *Phil. Mag.* or *Annals*, vii., 212, 1830; "Memorial of Joseph Henry," 1880, pp. 59, 81; "Lib. of Use. Know." (El. Mag.), pp. 24, 28, 83-92; Harris, "Rud. Elec.," pp. 170, 171, and "Rud. Mag.," p. 130; Noad, "Manual," pp. 661-682, 861-864; "Encyl. Metrop." (El. Mag.), vol. iv., pp. 5-8; Highton, "Elec. Teleg.," p. 39; Gmelin's "Chemistry," vol. i., p. 317; Mrs. Somerville, "Conn. Phys. Sci.," 1846, pp 320, 321; Dr. Lardner, "Lectures," vol. ii., p. 125; J. F. W. Herschel, "Prelim. Dis. Nat. Phil.," 1855, p. 243; Whewell, "Hist. Induc Sc.," 1859, vol. ii., pp. 242, 246, 619; "Ann. of Sc. Disc." for 1850, p. 129, and for 1865, p. 125; "Smithsonian Report" for 1873, p. 273; Sturgeon, "Sci. Researches," Bury, 1850, pp. 12, 16, 29; *Jour. Frankl. Inst.* for 1851, vol. xxii., p. 59; Turnbull, "El. Mag. Tel.," 1853, pp. 55 and 221; (Vail's "History," pp. 133, 134; Prof. Henry's Evid., 85, a, record; Doct. Channing's Ev., 47, a, record; Hillard, Ev., 31 a . . .). See also Humbo dt's "Cosmos," articles Aurora Borealis, Volcanoes, Earthquakes; Ampère et Bebinet, "Exposé des Nouv. Déc. . . ." de Oersted, Arago, Ampère, Davy, Biot, Erman, Schweigger, De la Rive, etc.," Paris, 1822, translated into German "Darstellung der neuen . . . dem Franzosischen," Leipsic, 1822, and alluded to in *Lumière Electrique*, for July 18, 1891, pp. 148, 149; 'Hatchette et Ampère," "Sur les Expér . . .; Oersted et Ampère, *Journal de Physique* for September 1820.

Calculation of a Small Electric Motor of 10 Kilogrammetres.*—I.

BY E. MEYLAN.

All builders of dynamo machinery worthy of the name are now in possession of methods and practical results which permit their constructing without difficulty a type of dynamo machine corresponding to such and such conditions, provided that they do not depart too widely from existing types and standard designs. The same applies without doubt to a great number of electricians and amateurs, at least if we may judge from certain inquiries which come to this journal, and we do not think we err in supposing that the trials of this nature result in numerous failures.

As we received for some time many requests of this character on the part of our subscribers, we think that we are rendering them a service by giving them two examples of a complete calculation of the elements of a small motor of 10 kilogrammetres. We have taken great care to choose two very different types, a motor with a Gramme ring armature and a motor of the Siemens drum type.

We will not insist in what follows upon the point of view of practical realization or the most economical conditions of construction. We will take a happy mean, and in one of the cases will take the dimensions suggested in part by one of our correspondents, while in the other we have chosen conditions most favorable from a practical point of view. The two motors are so designed that they will be perfectly practicable and will give the results indicated within the limits taken in this method of calculation.

It remains only to make a practical study of the arrangement of details and discuss carefully the question of the metal, either cast iron or cast steel, to be employed in the different parts, as well as the manner of arranging the joints in order to obtain a simple, strong and economical construction. That is the business of the builder who looks at it with a view to realizing profits, and who desires on the other hand, if he has any ambition, to create a type somewhat original. We will be content here to calculate, properly speaking, and to show what conditions it is necessary to satisfy in order to obtain the desired results.

Calculation of a Gramme Motor of Ten Kilogrammetres.—It is desired to obtain a series motor which at 100 volts will furnish an effective power of 10 kilogrammetres per second at a speed of 3,000 revolutions per minute. The type represented in Fig. 1 will be taken as a basis. We will not give general formulæ permitting the predetermination of dimensions; these formulæ are good for professors who never apply them. With a little practice one can get an approximate idea of the dimensions; make a first design which shows if the conditions are practicable, then modify it by numerous trials until a result satisfactory from that point of view is arrived at. We will give here only the result of the last calculation. We have taken a commercial efficiency of 60 per cent., which we will justify by the final results at the same time that we show by a brief discussion that it will not be advantageous to depart much from the results found.

The electrical values assumed will be: Volts at terminals, 100; electrical power absorbed, $\frac{10 \times 9\,8}{0.6} = 164$ watts, or, in round numbers, 170 watts. The current i will then be $\frac{17\,0}{10\,0} = 1.7$ ampères. The dimensions taken for the iron core of the armature are: Exterior diameter $D = 8.5$ centimetres; interior diameter, $d = 5.5$ centimetres; the width in the direction of the radius being $a = 1.5$ centimetre; the length in the direction of the shaft $b = 6$ centimetres; the number of turns on the armature $N = 1{,}500$, which can be divided into 30 sections with 30 bars on the commutator. The calculation of the resistance of the armature, in order to reduce as much as possible the air space so as not to force the excitation, requires us to take a wire of 0.6 millimetres, which with its insulation occupies a space of 0.7×0.7 millimetres; the mean diameter being about 8 9 centimetres there is a mean surface of about $8.9 \times 3.14 = 280$ millimetres. It is then possible to get $\frac{280}{0.7} = 400$ wires per layer, and with four layers it is easy to place the 1,500 turns.

The mean length of the turns being equal to $2(6 + 1.7) = 16$ centimetres, there will be a total length of 240 metres of wire of 0.6 millimetre diameter, of which the resistance will be about 14 ohms. The resistance of the armature will then be $\frac{14}{4} = 3.5$ ohms; the loss in volts $r_a i = 3.5 \times 1.7 = 6$ volts; the $i^2 r_a$ loss $= 6 \times 1.7 = 10$ watts.

The surface of the armature being equal to about 2.5 square decimetres that will correspond to a radiation of 4 watts per square decimetre, a value readily admissible and rather low. The length of the air space c is divided as follows:

Insulation	0.5 mm.
4 layers of wire: 4×0.7	3 "
Air gap including space occupied by the winding wires	2.5 "
Total	6 mm.

The useful magnetic flux which should traverse the core can be determined if we know the loss in volts due to the resistance of the field coils. A first calculation shows that this loss should be in the neighborhood of 12 volts; the counter E. M. F. e of the armature at a speed of 300 revolutions will then be equal to 82 volts (100—12—6); we can calculate then the flux by the formula

$$F = \frac{60}{n}\frac{e10^8}{N} = \frac{60}{3{,}000}\frac{82 \times 10^8}{1{,}500} = 110{,}000 \text{ C. G. S.}$$

* From *L'Electricien*.

The section of the iron being equal to $0.80 \times 2\,ab - 0.80 \times 3.\ 6 = 14.4$ cm.² *

The magnetic induction B will be equal to

$$B = \frac{110{,}000}{14.4} = 7{,}700 \text{ C. G. S.}$$

With the pole pieces which are shown, and which must be so shaped that the coils can, if necessary, be slipped over the top, the surface of the field equals

$$St = 9 \times 7 = 63 \text{ cm}^2.$$

We have taken as the surface that which corresponds to the normal projection of the extremities of the pole pieces by adding upon all sides 5 millimetres in order to take account of the diverging lines of force which are, however, received by the core.

The true intensity of the field will then be:

$$H = \frac{110{,}000}{63} = 1{,}750 \text{ C. G. S.};$$

$$H_m = \frac{F}{\frac{\pi}{2}(D + c)\ b} = 1{,}300.$$

We are now in a position to calculate the excitation—after a first approximation which enables us to roughly estimate the length of the core—since we can fix upon the values of the magnetic induction in the cores and the yoke. We will take 10,000 for these two values, supposing that the magnetic circuit, entirely of soft iron, is formed of a supporting yoke and the two circular field magnet cores, the extensions of which constitute the pole pieces. (See Fig. 1.) If we admit, moreover, a 20 per cent. loss of flux we will have for determining the sections of iron:

For the yoke:

$$S_y = \frac{1.20 \times 110{,}000}{10{,}000} = 13.2 \text{ (7 cm. } \times \text{ 2 cm.)}$$

and for the magnet cores;

$$S_c = \frac{1.20 \times 110{,}000}{10{,}000} = 13.2 \ (d_n = 4.2 \text{ cm.}).$$

We take for the magnetic properties of iron the mean values obtained from the curves and figures given by

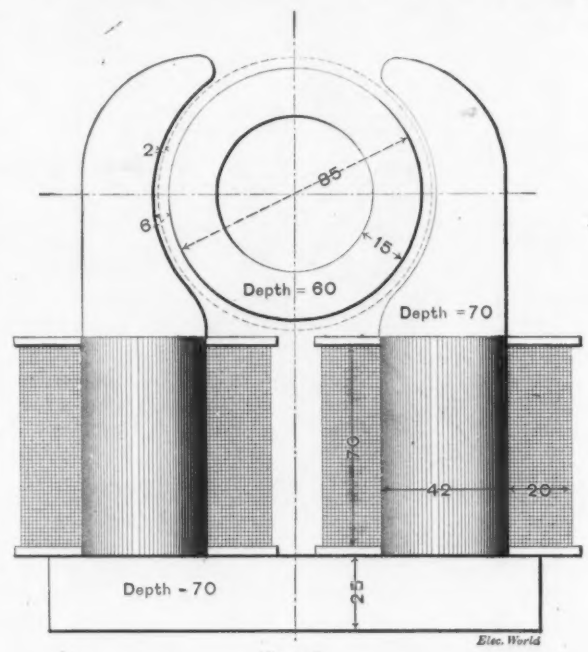


Fig. 1.

Messrs. Ewing and Hopkinson; for $B = 10{,}000$, $H = 8$; for $B = 7{,}700$, $H = 4.5$.

Estimating the total length of lines of force in the magnets as 30 cm. and in the armature core as 8 cm., we will have, for determining the excitation, the relation $4\pi n'i = \Sigma Hl$ C. G. S. which requires, for the excitation, in ampère turns:

$$n'i_{a-t} = \frac{1}{1.25}\left[\overbrace{\frac{2 \times 0.6 \times 1{,}750}{2{,}100}}^{\text{Air Space.}} + \overbrace{\frac{30 \times 7 + 8 \times 4.5}{250}}^{\text{Magnets and Yoke.}}\right] = 1{,}900$$

It is necessary then to take account of the reaction of the armature, which we will estimate at 300 ampère turns, or 16 per cent. of the excitation.†

It is therefore necessary to realize a total of 2,200 ampère turns, which with 1.7 ampères requires about 1,300 turns. As we have two coils and a single magnetic circuit it will necessitate 650 turns per coil. With wire of 0.9 millimetres diameter (one millimetre with the insulation) it will be necessary to make these coils 70 millimetres in length with a depth of wire of 19 millimetres. The mean turn having a diameter of 62 millimetres, the total length will be 260 metres, which corresponds to a resistance of $r_f = 6.5$ ohms. The loss in volts $= i\,r_f = 6.5 \times 1.7$ volts; the loss in watts $6.5^2\ r_f = 11 \times 1.7 = 19$ (5.5 watts per square decimetre). The total loss in volts due to the resistance of the motor is then equal to $6 + 11 = 17$ volts, although we have admitted a loss of 18; the speed can simply be reduced a little more than 10 per cent., and it is useless to repeat the calculation.

We must now calculate the loss due to hysteresis and to Foucault currents in the iron core. We will take the formulæ of Steinmetz, $T = \eta B^{1.6}$, assuming for η a high efficient 0.004, which corresponds to ordinary sheets, relatively thick. The work per cycle and cubic centimetre is then:

$$T = \frac{4}{1000}\ 7{,}700^{1.6} = 6{,}400 \text{ ergs.}$$

Since we have 50 cycles per second and 155 cubic centimetres of iron in our core, it will require for the power dissipated in that work:

$$W_h = \frac{6400 \times 155 \times 50}{107} = 5 \text{ watts.}$$

To sum up, we see, then, that of the 170 watts furnished to the motor there have been lost 19 in the wire on the field, 10 in the wire on the armature, and 5 in the core, a total of 34 watts. There remain, then, 136 watts actually transformed into mechanical work at the shaft, or 13.8 kilogrammetres per second. There remains a margin of 3.8 kilogrammetres per second, or 27.5 per cent. for friction in bearings and brushes, which is certainly below the actual. We have obtained, then, an efficiency of a little more than 60 per cent. or a little more than 10 effective kilogrammetres per second.*

We will add that the depth of the ring is equal to four centimetres and the depth of the pole pieces and yoke seven centimetres.

The weight of the wire on the armature will equal 0.6 kilogramme and that on the fields 1.6 kilogrammes, or a total of 2.2 kilogrammes of copper wire.

We will now discuss in a practical way the dimensions admissible with a speed of 3,000 revolutions. We will first say that it is difficult to reduce much the dimensions of the ring; in fact, to do that it is necessary either to increase the intensity of the field or to increase the number of turns on the armature, and therefore the length of the air space. These two modifications involve an increase of the excitation, but the coils occupy in width nearly all the available space (they will touch if the diameter of the ring be reduced); it is necessary, then, to lengthen the cores, and in that case it will become more cumbersome. The only advantage in this direction will be the increase of the arc embraced by the pole pieces, but it is necessary to state that in that case the cores will have to be slipped on at the lower end of the pole pieces.

The proportion of the length of the ring to the diameter can be materially modified without sensibly influencing the total values to be determined, but it should be added that with pole pieces of 7 centimetres in diameter they are already considerably larger than the cores; however, we would rather attempt to lengthen the ring than to shorten it.

There is no advantage, we think, in increasing the radial depth of the ring. The gain in hysteresis will be absolutely negligible as well as that in the excitation. We would gain a little in the flux, but the weight as well as the resistance of the armature would be increased.

As to the armature conductor, a loss of six volts is low. If we should increase the diameter but little would be gained—one or two watts, perhaps—while each millimetre of our space raises the excitation more than 140 ampère turns, or 3.6 watts, under the conditions which we have assumed.†

The diameter of the field wire, on the contrary, can be materially increased in order to diminish the cost, since we have there a little space to spare. If it should be necessary at any price to increase the efficiency, we can then lengthen the cores and increase the mass of the wire within certain limits.

We have taken a speed of 3,000 revolutions, as suggested by one of our correspondents It is a little high, and will not always be admissible. If it is necessary to decrease it, in taking the same general type of motor, it will require an increase in all the dimensions.

(To be continued.)

* The factor 0.80 takes into account the space occupied by the paper which insulates the metal sheets; it corresponds, for example, to sheets of 0.5 millimetre and to paper of 0.12 millimetre in thickness.

† This reaction is that which corresponds to a shifting of the brushes of 20° ($\pi : 9$). The counter magnetomotive force due to the armature of the shifting of the brushes will be: $\frac{4}{4}\pi Ni\ \lambda = 4 \times 1{,}500 \times 0.17 \times 0.35 = 355$ C. G. S. or in ampère turns $\frac{10}{4\pi}\ 355 = 280$ (in round numbers 300).

Electric Motors in Machine Shops.

Our contemporary "The Iron Age" in a recent issue states that "the electric motor has proved to be as reliable as, and more economical than, the line shaft. The electricity is conducted from the dynamo to the motor without an appreciable loss, and when the motor stops there is no loss because of useless motion." A favorable opinion, such as this, from a journal of such good standing, is certainly very encouraging. In the rest of the article it is stated that the chief objection to the introduction of motors in factories is their high speed, which, in the majority of cases, requires reduction. In conclusion it says: "The question is an exceptionally interesting one, and one that will compel close study and attention in the near future."

Proposed Telegraphic Tournament.

New York telegraphers are arranging for a telegraphic tournament, which will probably take place in Hardman Hall, Fifth avenue and Nineteenth street, on the afternoon and evening of Saturday, March 11.

* It is impossible to determine the frictions, since they depend entirely on the lubrication. A bearing can easily absorb 36 watts without, in all probability, having its temperature raised so that the hand cannot bear it.

† Account is taken of the fact that the exterior turns of the coils are much longer than the mean turn.

The Calculation of Alternating Current Motors.—I.

BY E. ARNOLD.

Since Mr. Tesla published his application of the Ferraris principle, and especially since the Frankfort Exhibition, much work has been done toward the development of the alternating current motor. The difficulties involved in the problem of meeting the proper requirements of a motor, and the wide gap between a mere principle of a motor and its practical application, both explain why it is that the production of good alternating current motors has progressed so slowly.

Alternating current motors can be divided into two groups: (1) synchronous motors; (2) non-synchronous motors. In both of these the simple alternating current as well as multiphase currents can be used. In the following both will be considered.

Synchronous Motors —These motors are characterized by separate excited field magnets, either by means of a continuous current or by means of a commuted alternat-

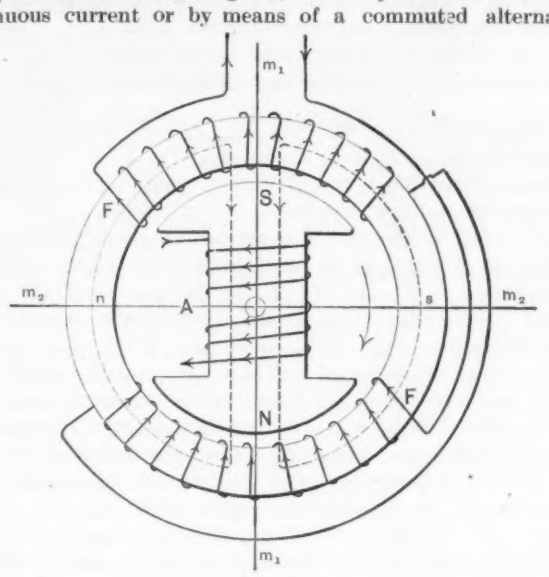


FIG. 1.

ing current. Fig. 1 shows a diagrammatic representation of a bipolar synchronous motor for a single phase alternating current. *A* is the armature excited by a continuous current, and *F* is the field through which the alternating current passes. The direction of the current at that particular moment is shown by arrows, and the armature is in the direction $m\ m_1$, which position it will take while running synchronously, when the current of the field has its maximum value. With the assumed polarity of the armature it will be turned to the right, due to the action between the magnetic field and the field current. After every half revolution this repeats itself, and the armature will therefore be able to generate power. If the frequency be n, then a bipolar motor will make n revolutions per second, while a multipolar machine with z pairs of poles will make $n \div z$ revolutions. The direction of the rotation with synchronous motors is not a definite one, as such motors have a dead point, from which it will turn equally well to the right or to the left. Fig. 2 shows the position at the dead point, which is perpendicu-

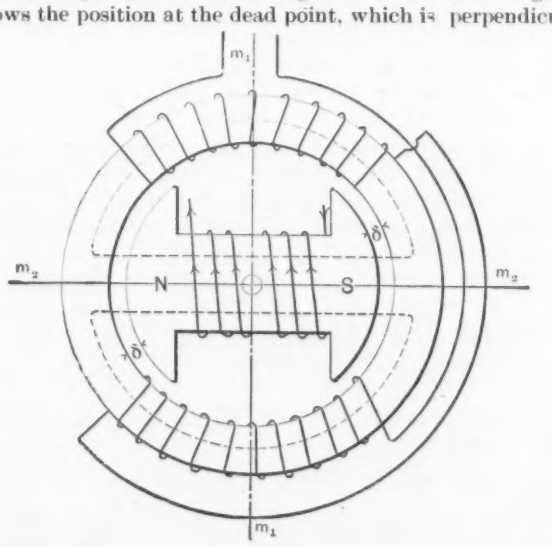


FIG. 2.

lar to the line m_1, m_1. If one tries to move the armature out of this position it will swing when released to both sides of the axis m_2, m_2, and will finally be held in this position. The armature takes such a position with reference to the field that the number of lines of force emanating and returning become a maximum in the field coils. If the armature moves synchronously with the field, the position m_2, m_2 will correspond with the time at which the alternation takes place. The reaction on the armature at this moment is equal to zero; but as soon as an overloading of the motor brings it out of synchronism this condition no longer exists, and the armature is brought to rest. The same is true of multiphase synchronous motors.

Let:

e_1 = the mean E. M. F. of the alternating current;

$E_1 = e_1 \sqrt{2}$, the maximum value of the same;

i_1 = the mean current strength;

$I_1 = i_1 \sqrt{2}$, the maximum value of the same;

φ_1 = the angle of displacement between E_1 and I_1;

L_1 = the coefficient of self-induction;

R_1 = the resistance of the field coils;

s_1 = the number of windings on same;

H = the mean field intensity (number of lines per square cm.) in the air space between the pole pieces and the field;

$p = 2\pi n$, in which n is the number of periods per second;

E_c = the counter E. M. F.;

A_1 = the energy delivered to the armature;

A_2 = the energy given out by the armature;

$g = \frac{A_2}{A_1}$, the efficiency of the motor.

The energy delivered to the armature is equal to

$$A = \frac{E_1 I_1}{2} \cos \varphi_1. \qquad (1)$$

The E. M. F. E_1 is balanced by three E. M. Fs., namely: (1st) the E. M. F. of the self-induction, of which the maximum value is $p L_1 I_1$; (2d) the effective E. M. F. $= R_1 I_1$, which the current I_1 requires to overcome the resistance R_1; (3d) the E. M. F. induced by the rotating field, which we call the counter E M. F. As the field H moves synchronously with the current I_1, the phase of the counter E. M. F. will coincide with that of the effective E. M F. The E. M. F. of self-induction, on the other hand, follows the current I_1 at a phase difference of 90 degrees, as the self-induction reaches its maximum when the current passes through zero.

If in Fig. 3 $A\ B$ is made equal to E_1, and if with $A\ B$ as a diameter a semi-circle is drawn, and if $B\ C = p\ L_1\ I_1$ laid off as a chord, then $A\ C = R_1\ I_1 + E_c$ and the angle $BAC = \sigma_1$.

The energy delivered to the armature is equal to the product of the current and the counter E. M. F. —

$$A_2 = \frac{E_c I_1}{2}. \qquad (2)$$

If H is the field intensity corresponding to the load A, then

$$E_c = F\ H\ p\ s_1; \qquad (3)$$

therefore

$$A_2 = \frac{F H p s_1 I_1}{2}. \qquad (4)$$

If the resistance R_1, which is small, is placed equal to zero, then it follows from Fig. 3 that

$$I_1 = \frac{\sqrt{E_1^2 - E_c^2}}{p L_1} \qquad (5)$$

and

$$A_2 = \frac{E_c}{2 p L_1} \sqrt{E_1^2 - E_c^2}. \qquad (6)$$

When the armature is at rest L_1 can be determined experi-

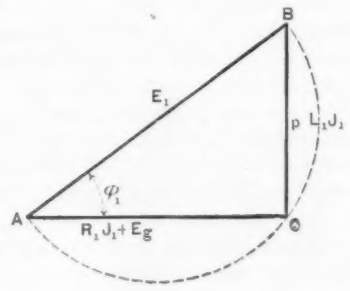


FIG. 3.

mentally, because then the counter E. M. F. is equal to zero.

If I_0 is the current delivered to the field at the voltage E_0, then it follows from Fig. 3 that $E_0^2 = p^2 L_1^2 I_0^2 + R_1^2 I_0^2$, and therefore

$$L_1 = \frac{\sqrt{E_0^2 - R_1^2 I_1^2}}{p I_0}, \qquad (7)$$

or by neglecting F_1 it follows approximately that

$$L = \frac{E_0}{p\ I_0}. \qquad (8)$$

If the armature or the field contains projecting poles or teeth, then the value of L_1 depends also on the relative position between the armature and the field.

With the aid of the equations (3), (7) and (8), the value of A_2 can be determined from equation (6) when E_1 is given.

The energy delivered to the armature is

$$A_1 = \frac{(R_1 I_1 + E_c) I_1}{2} = \frac{E_1 I_1}{2} \cos \varphi_1$$

and the efficiency

$$g = \frac{A_2}{A_1} = \frac{E_c}{R_1 I_1 + E_c}. \qquad (9)$$

The efficiency is, like in continuous current motors, the ratio of two E. M. Fs.

The losses through hysteresis, Foucault currents and excitation of the magnet are not included in this.

The phase difference between E_1 and I_1 becomes a maximum when $E_c = 0$; that is, when the armature is at rest. The larger the counter E. M. F., the smaller will be the angle φ_1. If the motor delivers no useful work, and if the armature runs synchronously with the field, then E_c has its maximum value; I_1 at the same time has its minimum value, as shown by equation (5).

The energy A_2 is evidently a maximum when, as shown in equation (6), the expression

$$E_c \sqrt{E_1^2 - E_c^2}$$

becomes a maximum. If the first differential coefficient is placed equal to zero, then

$$E_c = \frac{E_1}{\sqrt{2}}, \qquad (10)$$

which means: The effective energy A_2 is a maximum when the counter E. M. F. is equal to $1 + \sqrt{2}$ times the E. M. F., or when the maximum value of the counter E. M. F. is equal to the mean value of the E. M. F.

A_2 becomes a maximum when it is equal to

$$\frac{E_1^2}{4\ p\ L_1}. \qquad (11)$$

The torque D of the armature $= \frac{A_2}{w}$ in which w is the angular velocity. For a bipolar machine $w = p$ and

$$D = \frac{E_c}{p^2 L_1} \sqrt{E_1^2 - E_c^2}. \qquad (12)$$

The torque is therefore inversely proportional to the square of the frequency and to the self-induction coefficient.

This shows that in designing alternate current motors it is advisable to use the smallest possible frequency.

For synchronous multiphase motors the same results follow. If we have in general m alternating currents of equal maximum intensity, following the sine law, and having a phase difference of $\pi \div m$, then the above formulæ will hold for each phase. If every phase has an equal action, then

$$A_2 = \frac{m}{2} F H p s I, \qquad (13$$

or

$$A_2 = \frac{m}{2 p L} E_c \sqrt{E_1^2 - E_c^2},$$

$$I = \sqrt{\frac{E^2 - E_c^2}{p L}}. \qquad (14)$$

The letters I, E, and L refer to the single phases

(To be continued.)

Motors Without Counter E. M. F.

BY W.

To the Editor of the Electrical World:

In your issue of Dec. 21, 1892, I notice an editorial on "Motors Without Counter E. M. F.," in which the writer seems especially interested in the welfare of inventors and their friend supporters, and, as its intent appears to be to discourage inventors from tackling the problem, and to frighten capitalists by comparing a motor without counter E. M. F. with perpetual motion, I wish to say that I have seen some very ridiculous comparisons, but the one stated in the above-mentioned article is ahead of all.

It is stated in that editorial, that in the energy delivered to the motor, the "Ce part," which is the product of the current and the counter E. M. F., is that part which is converted into the useful work of the motor, and as the counter E. M. F. forms part of this, it ought evidently to be made as high as possible. This statement, as expressed, is not clear, and is suggestive of a cloud in the mind of some one.

In order to get a better understanding about this counter E. M. F., let us look to our best authorities, who state "that a motor (say a series motor) in starting develops no counter E. M. F.; but it can do its maximum work, yet its efficiency is zero. On the other hand, if the motor is a perfect one without friction, if allowed to run fast enough it will develop a counter E. M. F. almost equal to the E. M. F. which supplies the current. The motor is doing no work, and its efficiency is maximum." A nice thing, evidently, for a show case.

Now, if we want to obtain work from our motor with some efficiency, we may run it half way between these two extremities cited above, and call our motor efficiency anything.

From this it is apparent that the counter E. M. F. simple and plain acts as a resistance, or obstacle, to obstruct the current, which otherwise would flow through the motor. It is true that it is a very economical resistance, as it wastes no current in heat. It is also true that we cannot fully utilize the capacity of the current-supplying apparatus, and the motor is often credited with this counter E. M. F. in figuring out its electrical efficiency; but the owner of the beast, when he looks at his ponderous dynamos and engines, can't see it, nor can I.

Let us suppose a case of two like series dynamos, each of a capacity of 100 volts and 100 amperes, and let the resistance of each machine be one ohm. We use one as a generator and the other as a motor. Now, we load our motor so as to develop 50 volts counter E. M. F. What will be the result? The actual remaining useful pressure of the generator will be 50 volts, and will force 50 amperes through the one ohm resistance of the motor, which, leaving out minor losses, is equal to 50×50, 2,500 watts. And what did the generator produce? One hundred volts, 50 amperes, or 5,000 watts. It seems very much as if Jacobi was not so very far from the mark.

Now let us see what the performance of the motor will be if it does not develop counter E. M. F. Let us take the same case as before, generator 100 volts. 100 amperes, capacity 10,000 watts; the motor with one ohm resistance and no counter E. M. F. The 100 volts of the generator will force through one ohm resistance of the motor 100 amperes, at any desired speed; therefore the motor absorbs the total capacity of the generator, viz.: 10,000 watts.

It is true in the first case with a motor with counter E. M. F. that we could utilize the 100 amperes of generator capacity by using two motors with the same load, but

what would happen if we have to start both motors together under full load?

In the case of a motor without counter E. M. F., it may be so proportioned as to carry 100 amperes from the generator all day, even when at rest.

I have seen a motor without counter E. M. F. at work. Yes, and I will say I am personally identified with it, but I am not at liberty to say more about it just now. Perhaps the author of that editorial will be able to clear my mind a little on these points, if so, I should be glad to have him do so.

[Mr. W.'s first calculation of a supposed case of two series dynamos, founded on Jacobi's law, is only partially correct. He forgets to account for the other 2,500 watts delivered by the generator. The 50 volts counter E. M. F. × 50 amperes = 2,500 watts, which is the Ce part of the total, and is that which is converted into useful work, while the C^2R part = $50^2 \times 1$ = 2,500 watts, is that part which is irrecoverably lost in heat, exactly as if that current of 50 amperes were sent through a wire of one ohm resistance in a rheostat, or in the form of an air line wire. All this is converted into heat, and, therefore, cannot possibly perform any other work. This accounts for all the 5,000 watts delivered by the generator.

The second calculation is entirely wrong. The current of 100 amperes at 100 volts passing through one ohm resistance will, in accordance with the most elementary fundamental laws of electricity, be converted entirely into heat, no matter whether that wire forms the coils of a motor or of a rheostat, or any other conductor. There will therefore be nothing left of his 10,000 watts to be converted into useful work. If that motor runs at all, he will find that there does exist a counter E. M. F.; it may be a very small one, but it exists, and when multiplied by the current the product will be proportional to the horse power delivered by the motor, neglecting the minor losses. With such powerful currents the counter E. M. F. may be small, as the useful work is proportional to their product. At low speeds a motor may be doing very little work, even if the torque appears to be very great. To find this counter E. M. F. let him run his motor loaded (the greater the speed and load the better), and measure the current and voltage at its terminals. By clamping the shaft so it cannot move, and passing the same current through it, measuring the voltage again, the difference between these two voltages will be the counter E. M. F., provided there is not much sparking. This, multiplied by the current and divided into the brake horse power, reduced to watts, will give him his efficiency. (Care must be taken with the decimal point, so as not to obtain 90 when it should be 9 or perhaps .9. With strong currents, slow speeds and small powers, it may require a good voltmeter and ammeter to make the test properly.

The quotation from "our best authorities," though not exactly wrong, is one of those unfortunate, misleading statements that do so much mischief among beginners. A series motor does develop counter E. M. F. as soon as it revolves; furthermore, it does not do any work until it does revolve. As soon as it delivers any useful work at all it will be found to develop a counter E. M. F.

Mr. W. asks what would happen if his 100 ampere motors, having no counter E. M. F., were started under full load. The answer is: The result will be that the motors will soon "look very sick and will begin to smell badly."

Crediting the innocent generator with the counter E. M. F. is novel, ingenious and amusing, but the makers of the generators, or any educated electrical engineer, could readily show the deception and fallacy of this. Let Mr. W. put a meter in circuit between the generator and motor, and he will find it out for himself. To dispel the cloud which he infers rests on his mind, let him study a few good elementary books on the first principles of electricity, motors and dynamos.—Ed.]

The Ewing High Frequency Alternator and Parsons Steam Turbine.*

BY NIKOLA TESLA.

In your issue of Nov. 18† I find a description of Professor Ewing's high-frequency alternator, which has pleased me, chiefly because it conveyed to me the knowledge that he, and with him, no doubt, other scientific men, is to investigate the properties of high frequency currents. With apparatus such as you describe, shortly a number of experimenters, more competent than myself, will be enabled to go over the ground, as yet but imperfectly explored, which will undoubtedly result in the observation of novel facts and elimination of eventual errors.

I hope it will not be interpreted as my wishing to detract anything from Professor Ewing's merit if I state the fact that for a considerable time past I have likewise thought of combining the identical steam turbine with a high frequency alternator. Anch' io sono pittore. I had a number of designs with such turbines, and would have certainly carried them out had the turbines been here easily and cheaply obtainable, and had my attention not been drawn in a different direction. As to the combination, to which you give a rather complicated name, I consider it an excellent one. The advantages of using a high-speed turbine are especially great in connection with such alternators. When a belt is used to drive, one must resort to extraordinarily large diameters in order to obtain the necessary speed, and this increases the difficulties and cost of construction in an entirely unreasonable proportion. In the machine used in my recent experiments the weight of the active parts is less than 50 pounds, but there is an additional weight of over 100 pounds in the supporting frame, which a very careful constructor would have probably made much heavier. When running at its maximum speed, and with a proper capacity in the armature circuit, 2½ h. p. can be performed. The large diameter (30 inches), of course, has the advantage of affording better facility for radiation; but, on the other hand, it is impossible to work with a very small clearance.

I have observed with interest that Professor Ewing has used a magnet with alternating poles. In my first trials I expected to obtain the best results with a machine of the Mordey type—that is, with one having pole projections of the same polarity. My idea was to energize the field up to the point of the maximum permeability of the iron and vary the induction around that point. But I found that with a very great number of pole projections such a machine would not give good results, although, with few projections, and with an armature without iron, as used by Mordey, the results obtained were excellent. Many experiments of similar nature, made in the course of my study, demonstrate that the ordinary rules for the magnetic circuit do not hold good with high frequency currents. In ponderable matter magnetic permeability, and also specific inductive capacity, must undergo considerable change when the frequency is varied within wide limits. This would render very difficult the exact determination of the energy dissipated in iron cores by very rapid cycles of magnetization, and of that in conductors and condensers by very quick reversals of current. Much valuable work remains to be done in these fields, in which it is so easy to observe novel phenomena, but so difficult to make quantitative determinations. The results of Professor Ewing's systematical research will be awaited with great interest.

It is gratifying to note from his tests* that the turbines are being rapidly improved. Though I am aware that the majority of engineers do not favor their adoption, I do not hesitate to say that I believe in their success. I think their principal uses, in no distant future, will be in connection with alternate current motors, by means of which it is easy to obtain a constant, and in any desired ratio, reduced speed. There are objections to their employment for driving direct current generators, as the commutators must be a source of some loss and trouble, on account of the very great speed; but with an alternator there is no objectionable feature whatever. No matter how much one may be opposed to the introduction of the turbine, he must have watched with surprise the development of this curious branch of industry, in which Mr. Parsons has been a pioneer, and every one must wish him the success which his skill has deserved.

*From *The Electrician* (London).
†See THE ELECTRICAL WORLD, Dec. 17, 1892, p. 391.

Report of the Sub-Committee on Provisional Programme for the International Electrical Congress.

The accompanying report, prepared by the special subcommittee of the American Institute of Electrical Engineers, was received by the General Congress Committee at its meeting, held Dec. 28, 1892, and ordered to be printed for presentation to the Advisory Council of the World's Congress of Electricians, for consideration at its meeting, to be held Jan. 17, 1893. This arrangement is approved by Dr. Elisha Gray, chairman of the Committee on Electrical Congress, of the World's Congress Auxiliary.

To the General Congress Committee of the American Institute of Electrical Engineering:

The sub-committee understands its duties to be as fully submits to you the following report:

The sub-committee understands its duties to be as follows:

To suggest what work it is desirable to have done at the coming International Electrical Congress, to be held in Chicago in 1893.

To suggest a programme for carrying out this work in the most satisfactory manner to all parties, and with the least loss of time.

Regarding the work to be done, your committee's recommendations are as follows:

(1.) Ratification of the adoption of units, terms, symbols and definitions by previous International Electrical Congresses.

This is a mere matter of form, and an act of courtesy to the preceding congresses. Your committee understands that this was done at both the Paris congress of 1889 and the Frankfort congress of 1891.

(2.) Defining and adopting practical units for measuring and designating the measurements of the following quantities: Magneto-motive force; magnetic flux; magnetic intensity; magnetic reluctance; electric conductivity; illumination.

It will be noticed that this refers only to the question of what the magnitude of the units shall be, or, in other words, what multiples or sub-multiples of the absolute units they are to be.

Your committee is aware that objections are raised by some to the establishment of units not already in universal use. Past experience, however, has shown that the proper time to establish units is before their need is universally felt, in order to avoid the introduction by different persons or nations of units of different values, a contingency which will be very likely to arise, if not anticipated by concerted action.

Your committee recommends the following:

The value of the practical unit of magneto-motive force to be one-tenth of the absolute unit, that is, equal to $\frac{1}{4\pi}$ ampere turn.

The value of the practical unit of magnetic flux to be 10^8 absolute units or lines.

The value of the practical unit of magnetic intensity to be 10^8 absolute units, that is, 10^8 lines per square centimetre.

The value of the practical unit of reluctance to be 10^{-8} absolute units.

The value of the practical unit of electrical conductivity to be 10^{-9} absolute units, that is, to the reciprocal of the ohm. This makes it equal to the unit proposed some time ago, and known to some extent by the name of "mho." It should be given this value in order that it correspond with the already adopted units.

The value of the practical unit of illumination to be a bougie-decimale at the distance of one metre. The bougie-decimale is the unit of light or candle power already established, and is practically equal to one English standard candle; by making the distance a metre, the practical unit will be approximately equal to one-tenth of a carcel-metre, one-tenth of a foot-candle (or "lux") or to one metre-candle or metre-kerze, all three of which units are already in use to some extent.

It has been announced that a proposition will be made at this congress to change the values of some of the practical units, which have been adopted by previous congresses and are already in universal use. Among these are the ampere and the farad. It is urgently recommended by your committee that such changes should not be favored, since they would necessarily be followed by great confusion and would of necessity have to be accompanied by some change in these well established names in order to distinguish these new units from those now existing.

(3.) Adopting names for the following practical units: Magneto-motive force; magnetic flux; magnetic intensity; magnetic reluctance; inductance; electrical conductivity; illumination.

The following names are suggested for these units:

For the practical unit of magneto-motive force the name "gilbert."

For the practical unit of magnetic flux, the name "weber." This term was formerly applied to a unit of current, but its use in this sense was so limited, and it has been abandoned for so long a time, that no confusion would be likely to arise; the context alone would always be sufficient to prevent any possibility of misunderstanding. The name "weber" is preferred on account of the intimate relation between this unit and that of magnetic intensity, for which the name "gauss" is suggested.

For the practical unit of magnetic intensity, the name "gauss." This name has already come into use to such an extent that objections to it will not be likely to arise.

For the practical unit of magnetic reluctance, the name "oersted."

For the practical unit of inductance, the name "henry." This name has already come into use quite extensively, and it would, therefore, be very undesirable to change it. The value of this unit has already been fixed as equal to 10^9 absolute units or nearly to the length of an earth's quadrant. The definition "quadrant" is sometimes employed as the name itself, but its use as a name is evidently objectionable, as it already has several other meanings, which might readily lead to confusion.

For the practical unit of electrical conductivity, equal to the reciprocal of the ohm, the name "mho." This name has been in use for some time and is already well known. It is thought better to recommend it than to select and introduce a new name.

For the practical unit of illumination defined above, the name "bougie-metre."

It has been suggested to name the units "kilowatt-hour" and "ampere-hour." Your committee, however, recommends that inasmuch as these terms explain themselves, and are not longer than some others in use, to give them special names would burden a system of no-

*See THE ELECTRICAL WORLD, Dec. 10, 1892, p. 375.

menclature unnecessarily. The principal objections to the term "Board of Trade unit," which is in use in England for the former, are, that it could never become international, that it is longer by one syllable that the term "kilowatt-hour," and that there are now, or may soon be, units of other denominations adopted by the same Board of Trade, from which this one will have to be distinguished by an additional affix or prefix.

(4.) Defining and adopting modes of embodying the following principal units of measurement in concrete standards capable of being readily reproduced, and adopting names for them or for the theoretical units, by which they can be distinguished from each other: Ampere, ohm, volt, watt, standard candle.

The following definitions of these units are recommended:

An ampere shall be that unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specifications recommended in the recent report to the British Board of Trade, deposits silver at the rate of 0.001118 of a gramme per second.

An ohm shall be the resistance offered by a column of mercury at the temperature of melting ice 14.4521 grammes in mass, of a constant cross-sectional area, and of a length of 106.3 centimetres. It is recommended that material standards of this value, constructed in solid metal, should be preserved under the care of the several governments, as standards of comparison, and that they should from time to time be verified by comparison with the mercury standard defined above; also, that for the purpose of replacing the standard, if lost, destroyed or damaged, and for ordinary use, a limited number of copies should be constructed which should be periodically compared with the standard ohm.

A volt shall be the product of this ampere and this ohm.

A watt shall be the product of the square of this ampere and this ohm.

The other units, such as the coulomb, the farad and the joule, shall be taken as derivatives in terms of this ampere and this ohm.

In order to create as little confusion as possible by the introduction of this set of units, which are to become the universal standards, and in order to distinguish them readily from the true theoretical or abstract units, defined in terms of the absolute units, it is recommended to call the former simply "amperes," "ohms," "volts," etc., or more specifically "standard amperes," "standard ohms," etc., and to call the theoretical units "true amperes," "true ohms," etc. The latter term has already come into use in this sense.

The unit of resistance, known as the B. A. unit, shall be taken as equal to 0.9866 of this ohm.

The electromotive force of a Clark cell at 15° C., prepared in accordance with the specification recommended in the recent report to the British Board of Trade, shall be taken as not different from 1.434 of these volts by more than one part in one thousand. The coefficient of temperature shall be taken as—?

The standard candle shall be taken as equal to the light from a lamp, like that known as the Hefner-Alteneck standard amyl acetate lamp, which is to be defined by its dimensions and the height of the flame, the dimensions being such that the light shall be equal to that of the "bougie-decimale," the practical unit adopted at the Paris Congress of 1889, which is equal to one-twentieth of the absolute platinum standard adopted in 1884.

It has also been suggested that a universal wire gauge be defined and adopted. Desirable as this may at first seem, your committee recommends that no action be taken by the Congress in this matter, as it is not likely that any one scale would ever be universally adopted by manufacturers, even if defined and adopted by a congress. The universal introduction of the metric system and the designation of wires by their diameters in millimetres is thought to be the only satisfactory solution of this question for international work.

(5.) Adopting an international system of notation and conventional symbols for designating different quantities.

The system suggested to the last congress by Mr. E. Hospitalier, of Paris, is recommended by your committee, although doubtless some amendments may be found desirable.

(6.) Defining the following terms: Impressed electromotive force, inductivity, inductance, real activity, Matthiessen's standard, north and south pole.

The following definitions are suggested:

The impressed electromotive force is the ratio of the total activity in an electrically conducting circuit to its instantaneous current strength.

The inductivity at any point in an isotropic medium is the ratio, added to unity, of 4π times the intensity of magnetization there existing, to the magnetizing flux density. Inductivity is synonymous with "permeability." The electromagnetic dimensional formula is $L^\circ M^\circ T^\circ$; the conventional symbol is μ.

Inductance.—(a) Self-inductance is the ratio of the total magnetic induction, linked with and established by an electric current, to the uniform strength of the same. The inductance of a conducting circuit is constant when its environing medium has constant inductivity. (b) The mutual inductance of one electric circuit upon another is the ratio of the total magnetic induction linked with the second, due to a uniform current in the first, to the strength of that current. The mutual inductance between two electric circuits is reciprocally equal when the environing medium has constant inductivity. The electromagnetic dimensional formula is $L^1 M^\circ T^\circ$. The absolute unit is one centimetre; the practical unit, one henry.

The reluctivity of a medium at any point is the volume differential of the reluctance thereat. Simple definition: Reluctivity is the reluctance per unit volume. The electromagnetic dimensional formula is $L^\circ M^\circ T^\circ$. The absolute unit is one C. G. S. unit of reluctance per cubic centimetre; the proposed practical unit is the same, or about one oersted per cubic earth quadrant.

The resistance of copper known as Matthiessen's standard shall be defined as follows: The resistance of a soft copper wire one metre long, weighing one gramme, is 0.14365 B. A. units at 0° C. This definition is recommended by the Committee of the American Institute of Electrical Engineers on Matthiessen's standard. The reasons for selecting it are given in that report.

The north pole of a magnet to be defined as being that which seeks the geographic north pole, and the south pole that which seeks the geographic south pole. This is the generally accepted definition, but it is thought desirable to formally define it.

Defining and adopting expressions: For alternating currents of more than one phase; for describing phenomena of alternating currents and of electro-magnetic waves.

It is recommended to adopt the following expressions: "simple" alternating current for the usual alternating currents in which there is practically but a single phase; "diphase" alternating currents for two alternating currents whose phases differ in time by 90° or 270°; "triphase" alternating currents for three alternating currents whose phases differ in time by 60° or 120°; "polyphase" alternating currents for such as have more than three phases.

For expressions describing phenomena of alternating currents and electromagnetic waves your committee solicits suggestions.

(8.) Recommending the more universal use:

Of the term "voltage" as synonymous with "difference of electrical potential" or P. D. in place of the terms "potential," "tension," or "pressure," the use of which in this sense it is recommended to abandon;

Of the term "transformer" instead of "converter;"

Of the term "dynamotor" for a continuous current transformer;

Of the term "continuous current" instead of "direct current;"

Of the term "kilowatt" instead of "horse power."

Of the metric system of weights and measures, and suggesting means by which its introduction will be facilitated.

Programme.

Regarding the programme for carrying out this work in the most satisfactory manner to all parties, and with the least loss of time, your committee's recommendations and suggestions are as follows:

It cannot be too strongly urged that an International Congress is the place to close, but not to open, a discussion on questions about which international agreement is to be had; it is therefore urgently recommended that action be taken at once to open the discussion of such matters now, in order that expressions of opinions, and, if possible, agreements, may be arrived at prior to the meeting of the Congress. To this end your committee recommends that the suggestions embodied in this report, or as many of them as you see fit to designate, be printed and sent to all the leading electrical and physical societies and journals in this country and abroad, with a request that they aid this work by making them public, by freely discussing them, and by sending copies of such discussions and any further suggestions to the General Congress Committee of this Institute, care of the secretary, 12 West Thirty-first street, New York City. That a sub-committee of the Institute prepare from time to time a classified summary of such discussions to be sent to the leading electric and physical journals for publication here and abroad, and that it present a final summary of this international discussion at the Congress. This discussion ought to be closed by July 1, 1893.

It is recommended also that this Institute invite other societies to co-operate with it by appointing special committees to discuss and report to their respective societies on these international questions and to publish their conclusions in the electrical journals of their country.

It has been suggested that various committees be appointed to prepare reports on the international questions on which agreement is desired, and to submit these at the meeting of the Congress. Your committee, however, believes that to postpone the discussion until the Congress is in session would lead to no satisfactory results, as was shown at the last congress of 1891, in Frankfort. It therefore urges that the discussion take place through the medium of the journals prior to the meeting of the Congress, and that the only report submitted to the Congress be a summary of such discussions.

Regarding the meetings of the Congress, your committee recommends that, as in the Paris Congress of 1889, the meetings be divided into (a) General Meetings, one at the opening and one at the closing of the Congress, which are to be devoted to the consideration of general questions and those on which agreements are desired, and to the reading of papers of a general character; (b) Sectional Meetings for the reading of all other papers. The following division into sections is recommended:

1. Electrophysics, units, measurements, and all electrical matters of a purely scientific nature.
2. Dynamos, motors, transformers, etc.
3. Systems, central stations, installations, lamps, etc.
4. Electric telegraphy, telephony and signalling.
5. Electric railways.
6. Electrochemistry, batteries, electrometallurgy.
7. Electrophysiology and electrotherapeutics.
8. Legal questions.

It is suggested that specific invitations be extended by the Congress Auxiliary to prominent electrical engineers and physicists to prepare papers on specified subjects to be read and discussed at the Congress meetings. Also, that a general invitation be extended for other papers, which are to be submitted not later than July 15, 1893, to a committee on papers appointed by the chairman of the Congress Auxiliary; that this committee shall examine and accept or return the latter, and at its discretion shall print any or all of those accepted as well as those solicited, in form for circulation at least one week prior to the meeting at which they are to be read; that the papers shall be read in full, in abstract or by title, as that committee shall direct.

The following subjects of papers are offered as a suggestion to the Congress Auxiliary merely as a basis and not as a complete list:

The criterion of sensitiveness of galvanometers; or, on the theory of their construction.

The working of national or municipal laboratories for testing meters and instruments.

The practical results and economy of the employment of accumulators in central station systems of supply.

On the relation between weight of copper and iron in dynamos and their output.

Nomenclature and notation of magnetic circuit—or on standard and units of magnetism.

Magnetism.

On the economic use of transformers under various conditions of supply.

Electricity meters from a European standpoint.

Electricity meters from a British standpoint.

Electricity meters from an American standpoint.

Choice of materials for standard of electrical resistance.

Nomenclature of phenomena of electro-magnetic waves.

Standards for electrical measurement.

Alternating current transformers from an American standpoint.

High frequency and high potential phenomena.

Dynamo construction.

Your committee suggests that papers should be solicited by the General Congress Committee of this Institute on the work of the early electricians of this and foreign countries, considered from a modern standpoint, and their importance in the development of the science of electricity, including descriptions and illustrations of models and apparatus used.

Your committee suggests that the proper authorities be requested to have a stenographic report made of the proceedings and discussions at all the meetings of the Electrical Congress, and that this report, including such of the papers and discussions as a committee appointed for the purpose shall direct, shall be printed and published in book form; that each member of the Congress be entitled to one copy of this report on the payment of $1 and non-members on the payment of $5.

It is suggested that the membership of the Congress be divided into delegated members and members; that the dues for each shall be $5; that only delegated members and members be admitted to the meetings and be permitted to take part in the discussions; that any one shall be entitled to become a member; that delegated members shall be appointed by governments, physical and electrical societies, and shall be approved by an international committee whose decision shall be final; that questions on which international agreement is desired be decided by the delegated members, whose decisions shall be submitted to the whole Congress for approval or rejection in part or in whole, but not for alteration.

It is recommended that the United States government be requested to extend a formal invitation to foreign governments and societies to send delegates to this Congress.

In the present report your committee has embodied recommendations from the reports of the Institute's Committee on Matthiessen's Standard, and on Magnetic Units, from the recent reports of the British Board of Trade Committee, and from the suggestions of Dr. Silvanus P. Thompson to Dr. Elisha Gray, in reference to the Congress. Respectfully submitted,

(Signed) CARL HERING, Chairman,
WM. A. ANTHONY,
A. E. KENNELLY,

The Tension in Ferranti Cables.*

BY DR. BEHN ESCHENBURG.

When an alternating current is passed through an underground concentric cable, like those of Ferranti, it is of interest in practice to know what the difference of potential is between the earth and the outer and inner conductors of the concentric cable, that between the conductors themselves having a known value. The following simple theoretical deduction, which practical tests have confirmed, may be sufficient in all cases to calculate approximate values of this tension.

Diagrammatically the current of the dynamo may be represented as being divided, one part charging the cables as condensers and the other being the useful current which is conducted to the distant end. Let the difference of potential at the poles of the machine at a certain moment be

$$E = P_1 - P_2$$

Let the current which will enter the cable as shown in the adjoining figure be represented by C, of which the portion C_1 will be led to the place of consumption L, while the portion C_2 will charge the condenser k, which is formed of the outer conductor on the one hand and the earth and the inner conductor on the other. The current in the inner conductor charges the condenser k_2. Let the potential at the condenser plates k_1 and k_2 be P_1' and P_2'.

Let the electrostatic capacity of the condenser k_1 be K_1, when one pole is the earth and the other pole the outer conductor, and when the inner conductor is assumed to have no effect on the charge.

Let the capacity of k_1 be K_3 when the earth is supposed to have no effect on the charge of the condenser formed of the inner and outer conductors by themselves. Let the corresponding capacities of the condenser k_2 be K_2 and L_2.

The following relations will then exist:

$$C = C_1 + C_2 \qquad (1)$$

$$C_2 R_2 = P_1 - P_1' = -P_2 + P_2' \qquad (2)$$

The inner and the outer conductors of the cable will then be alternately discharged to the earth through a conductor of a resistance r and having a self-induction coefficient l, when we consider the condenser k_1. The condenser k_2 will be discharged through a conductor of a resistance r_2 and self-induction coefficient l_2. It should here be assumed that the conductors through which the discharge takes place consist of measuring instruments or leaks in the insulation.

The following equations may then be deduced if c_1 and c_2 be the current strength of the discharge of k_1 and k_2 respectively, in case only K_1 is discharged:

$$K_3 \frac{d(P_1^1 - P_2^1)}{dt} + K_1 \frac{d P_1^2}{dt} C_2 - c_1 \qquad (3)$$

$$K_3 \frac{d(P_1^1 - P_2^1)}{dt} - K_2 \frac{d P_2^1}{dt} = C_2 \qquad (4)$$

$$c_1 r_1 + l_1 \frac{dc}{dt} = P_1^1 \qquad (5)$$

and when k_2 is discharged:

$$K_3 \frac{d(P_1^1 - P_2^1}{dt} - K_2 \frac{d P_2}{dt} = C_2 - c_2 \qquad (3a)$$

$$K_3 \frac{d(P_1^1 - P^1{}_2)}{dt} + K_1 \frac{d P_1^1}{dt} = C_2 \qquad (4a)$$

$$c_2 r_2 + l_2 \frac{d c_2}{dt} = P_2^1 \qquad (5a)$$

From (3), (4) and (5) it follows by simple substitution, when l_1 and l_2 can be neglected

$$c_1 = (K_1 + K_2) r_1 \frac{d c_1}{dt} + K_2 \frac{d(P_2^1 - P_1^1)}{dt}$$

and on the other hand

$$c_2 = (K_1 + K_2) r_2 \frac{d c_2}{dt} - K_2 \frac{d(P_2^1 - P_1^1)}{dt}$$

If we may assume the resistance r_2 to be exceedingly small, as it is in practice, then

$$P_2^1 - P_1^1 = -E$$

and when E is a sine function of the time, as for instance

$$E = E \sin 2\pi n t$$

in which n represents the frequency, then

$$c_1 = -\frac{E\, 2\pi n K_2 \cos(p t + d_1)}{\sqrt{1 + (K_1 + K_2)^2 r_1^2 (2\pi n)^2}}$$

from which it follows that

$$P_1 = c_1 r_1 = -\frac{E\, 2\pi n K_2 r_1 \cos(p t + d_1)}{\sqrt{1 + (K_1 + K_2)^2 r^2 (2\pi n)^2}}$$

If now, in a Ferranti cable, with the assumed discharge conductor,

$$(K_1 + K_2) r_1 (2\pi n)$$

is greater than 1, then we may say, approximately, that

$$P_1 = -\frac{E K_2}{(K_1 + K_2)}\left(1 - \frac{1}{2(K_1+K_2)^2 r_1^2 (2\pi n)^2}\right)\cos(pt - d_1,$$

$$P_2 = +\frac{E K_1}{K_1 + K_2}\left(1 - \frac{1}{2(K_1+K_2)^2 r_1^2 (2\pi n)^2}\right)\cos(p t + d_2)$$

The average values of P_1 and P_2 may therefore be assumed as

$$P_1 = \frac{E K_2}{K_1 + K_2}$$

$$P_2 = \frac{E K_1}{K_1 + K_2}$$

$$\frac{P_1}{P_2} = \frac{K_2}{K_1}$$

If the self induction of coefficients of the discharge conductors are large compared to their ohmic resistance, as for instance, in the discharge through transformers for measuring apparatus of which the secondary current is used for a voltmeter, the following equation will result:

$$c_1 = -(K_1 + K_2) l_1 (2\pi n)^2 c_1 - K_2 \frac{d E}{d t}$$

$$c_1 = -\frac{E(2\pi n) K_2 \cos(p t + \beta_1)}{1 + (K_1 + K_2)(2\pi n)^2 l_1}$$

and if 1 in the denominator is small in comparison to the whole denominator, then

$$P_1 = l_1 \frac{d c_1}{d t} = +\frac{E K_2}{K_1 + K_2}$$

as above.

There is always a limit for r_1 or $2\pi n l_1$, beginning with which, the expressions

$$(K_1 + K_2) 2\pi n r_1$$

or,

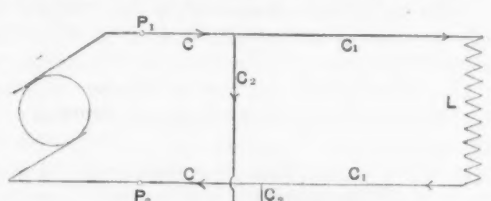
$$(K_1 + K_2)(2\pi n)^2 l_1$$

in the denominator for c will be small compared with 1; from this limit on, c_1 will no longer increase appreciably with a decrease in the resistance of the discharge.

These equations also show plainly what a mistake it is to use on the Ferranti cables the well known ground detectors, which are regulated for a fixed resistance regardless of the capacity of the cable, as, for instance, in the ground detector of Messrs. Hartmann & Braun, which indicates the discharge current which in all practical cases will be very much larger than the one for which the instrument is made for the case of a complete short circuit with the earth.

In conclusion, I give here a few measurements on a Ferranti cable 2.3 kilometres (nearly 1½ miles) long in the network of the municipal plant at Zurich, which the Oerlikon company has lately installed.

The voltage of the machine was 1,800 volts at a frequency of 50. The total capacity of the outer conductor (there are three conductors in parallel) is four microfarads. The capacity of the inner conductor in reference to the outer lead coating connected to the earth is negligibly small, as the outer copper conductor encloses the inner almost completely, so that the inner is almost completely protected against induction from the outside, and external conductors are similarly protected against induction from it. The inner conductor, when compared with the earth, will therefore have almost the full difference of potential of the dynamo while that of the outer conductor will be negligibly small as compared with the earth. In an actual case this potential could be noticed only by means of a telephone, while the other was 1,800 volts. If now the outer conductor be connected to the earth, the above equations will have to be changed in so far that now there are charges only between the inner and the outer conductors. These charges, as is well known, be it that the outer or the inner copper is connected to the earth, always lead to disturbances in telephones when the equalizations of the potential in the earth can find their way through telephone lines.



THE TENSION IN FERRANTI CABLES.

In our case the maximum discharge current between the inner copper and the earth is 2.5 ampères. Therefore only such of the ground detectors of Hartmann & Braun can be used as at 2.5 ampères still show complete insulation, which can be effected by a shunt.

The following combination may be of even more interest than the normal case just described; this combination happened by accident to exist in the underground conductors of the installation just mentioned. The mains, which carried the current from the generating station to the substations in the city, had been connected to a few distribution lines in the city in such a manner that the *inner* copper conductor for the distribution cable was joined to the *outer* conductor of the main cable and the outer conductor of the distribution cable with the inner conductor of the main cable.

In this case the capacity of the outgoing and incoming circuits will divide itself according to the capacity of the distribution cable to which it is joined, in comparison to the capacity of the main cable. It was noticed, for instance, at seven distribution cables which were thus wrongly connected that there was a difference of potential between the outer main conductor and the earth, of 600 volts; between the inner copper and the earth, 1,200 volts; with three wrongly connected distribution cables there was an external potential of 300 volts and an inner of 1,500 volts. In the first case the maximum discharge current of the outer cable was less than one ampère, which was shown by means of a fuse wire.

This combination of connections in the cables resulted in disturbances in those telephone lines of the city which were affected by discharge currents in the direction of the cable. As the lead covering, which is connected with the earth, is made in various pieces which are connected by small conductors in the junction boxes, and as this mantle itself does not make equally good earth connection along the whole line, the telephone lines in certain directions will offer less resistance to the current which keeps the potential at zero. It was noticed that the telephone disturbances became less when a connection was made between the outer lead covering to both sides of the junction box; and that when all connections between the distribution cables and the main cables were made normally, all telephone disturbances disappeared. Every earth connection of a secondary or primary, outer or inner conductor, or even of the central neutral wire, caused an appreciable disturbance in the telephones quite similar to that noticed in the three-phase current plant Killwangen-Zurich, described in the *Electrotechnische Zeitschrift*, No. 29.

*From *Electrotechnische Zeitschrift*, Nov. 4, 1892.

Experimental Researches on Alternate Current Transformers.—III.*

BY DR. J. A. FLEMING.

In Fig. 4 is shown a curve representing the values of $W_1 - W_2$ for the Ferranti 5-h. p. transformer, taken from the results in Tables V. and VI. The secondary output of the transformer in watts is set off on the horizontal line, and the vertical ordinates of the upper curve are the corresponding values of the "total lost watts," or total power

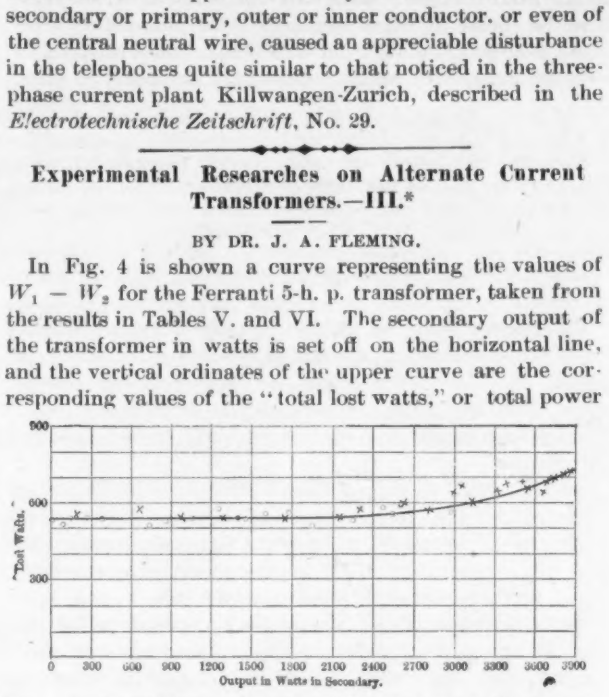


FIG. 4.—FIVE-HORSE POWER (1885 PATTERN) FERRANTI TRANSFORMER. LOSSES BY THREE-VOLTMETER METHOD.

losses in the transformer at these various loads. The lower curve is the curve of total copper (C^2R) losses, taking both primary and secondary together. The difference between the ordinates of the upper and lower curves represents the power lost in the transformer in iron losses and eddy current copper losses, if any. It is seen that the upper curve keeps roughly parallel to the lower curve, and that therefore, as far as these observations go, there is no indication that the core losses get less as the output increases; on the other hand, they seem to get slightly greater. It is much more convenient and instructive to plot out in this way a "total loss curve" for the transformer than to plot an efficiency curve, for if an accompanying C^2R curve is drawn it shows us at once what is the magnitude of the total eddy current and hysteresis losses to be accounted for. The values of $W_1 - W_2$ for the Swinburne "hedgehog" are found, when plotted, to lie so irregularly that an exact determination of the total loss curve by these tables is impossible. The power factor of the "hedgehog," even at full load, is still small, and we were not satisfied with the general nature of the results given at all loads by the three-voltmeter method for this transformer. In the case of the Ferranti 5 h. p. transformer (1885 type), the determination of the power taken up at no secondary load was fairly consistent. The mean value is 520 watts. The mean of all, corresponding to a frequency of about 83, is probably close to 540 watts, as given in Table I.

III.—EXPERIMENTS WITH THE THREE-AMMETER METHOD OF MEASURING ALTERNATING CURRENT POWER.

10. We next directed our attention to that modification of the voltmeter method suggested by the writer, and which involves current measurements instead of pressure.

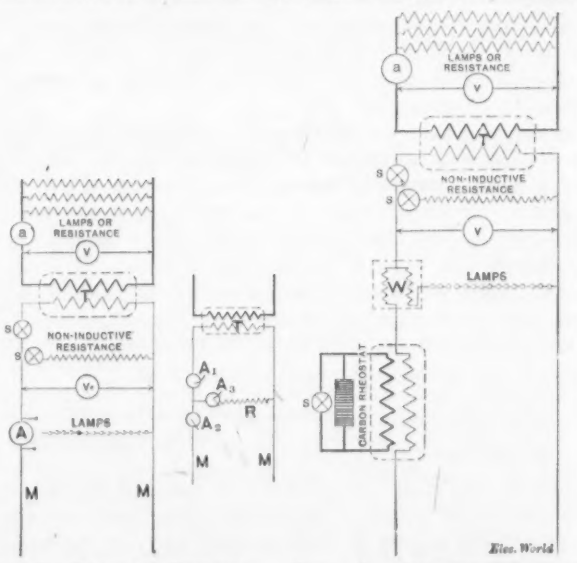


FIG. 5.—PLAN OF CONNECTIONS FOR THREE-AMMETER METHOD.

FIG. 6.—CONNECTIONS OF DYNAMOMETER FOR WATTMETER METHOD.

Theoretically, this method requires three ammeters, A_1, A_2, A_3, arranged in connection with the transformer under test, as shown in Fig. 5. In putting this method into practice we found it necessary, in the first place, to scheme some simple method of regulating the P. D. at the terminals of the transformer under test. This was accomplished as follows: A 10-h. p. transformer had its primary or fine wire circuit inserted in series with the primary current of the transformer under test. The secondary, or thick wire,

* Abstract of a paper read before the Institution of Electrical Engineers (London). For the first and second sections see THE ELECTRICAL WORLD (Dec. 24, 1892, p. 413, and Jan. 7, 1893, p. 15).

circuit of the 10-h. p. transformer was closed through a variable resistance, consisting of 15 to 20 plates of battery carbon, 3 inches square and ¼ inch in thickness, pressed together more or less by a screw clamp. By suitably compressing these plates we were able to regulate with great nicety the secondary current of the 10-h. p. transformer, and hence to adjust the resultant impedance of the primary circuit of the 10-h. p. transformer. The volts at the terminals of the transformer under test could then be kept perfectly constant, irrespective of slight variations due to the dynamo. As a non-inductive resistance, we employed a series of 50-c. p. incandescent lamps. We then found that, working under these conditions, we could dispense with the third ammeter, A_3, and make one measurement once for all of the current taken by this series of lamps at 2,400 volts.

The experiments consisted, therefore, in measuring the primary current of the transformer under test by two ammeters in series, from the junction point of which was led off the constant current for a series of lamps. The P. D. at the ends of this series of lamps was kept perfectly constant at 2,400 volts, as shown by the voltmeter, V. We found considerable difficulty in getting two suitable ammeters for the positions A_1 and A_2 which would agree with one another with the requisite accuracy, and finally we reduced the method to the use of a single ammeter, as follows: An ammeter was put in the primary circuit of the transformer under test, and the P. D. at the terminals of this transformer was kept constant at 2,400 volts. A series of incandescent lamps (generally 24 lamps of 100 volts and 16 c. p. was joined across the primary mains, and two readings of the ammeter taken—a first when the row of lamps was between the ammeter and transformer, and a second when the ammeter was between the lamps and transformer. An independent determination was made of the current taken by the lamps. These changes of position of the ammeter were made by mercury cup connections, so as to avoid at any time actually breaking the primary circuit. As an ammeter, we employed first an Ayrton and Perry twisted strip ammeter, and finally a Siemens dynamometer of low resistance. It will be easily seen that this single ammeter method possesses all the advantages, whatever they are, of the three-ammeter method, and is much simpler to work.

If A_1 is the reading of the ammeter when it is between the transformer and the lamps, and A_2 the reading when the lamps are between it and the transformer, and A_3 is the value of the current through the lamps, and V the P. D. at the terminals of the series of lamps, it is easy to show that the power, W, taken up in the transformer is given by the expression,

$$W = \frac{V}{2A_3}\left\{A_2^2 - A_1^2 - A_3^2\right\}.$$

In spite of its greater simplicity, the one-ammeter method did not give very satisfactory results, even on closed magnetic circuit transformers. It was applied to test the Swinburne 3,000-watt "hedgehog" when on open circuit. It was found here that, as in the case of the three-voltmeter method, still greater difficulty was experienced in getting experimental results which agreed numerically well together.

The conclusion arrived at with respect to this ammeter method is that ordinary commercial ammeters do not enable us to determine the currents with anything like the accuracy necessary when we are operating on open magnetic circuit transformers at no load. It would be necessary to read currents of magnitudes from 0.25 to 5 ampères to the third decimal place, and that is not in general a practicable matter by commercial instruments. After many further trials of this method on different transformers, we were obliged to come to the same conclusions with respect to it as those forced upon us in regard to the voltmeter methods, viz., that it is an unsuitable one for transformers of small power factor, but that with great care and a suitable ammeter it may be made to yield fairly good results for closed magnetic circuit transformers of large power factor. It may be noted in passing that in applying this ammeter method in any case the most favorable condition for accuracy is when the current through the transformer primary is equal to the current through the non-inductive shunt. Hence the shunt resistance should be decreased as the load on the secondary of the transformer is increased if we desire to obtain a uniform possibility of accuracy in measurements of the power supplied.

IV.—EXPERIMENTS WITH THE DYNAMOMETER-WATTMETER METHOD OF MEASURING ALTERNATING CURRENT POWER.

11. Dissatisfied on the whole with the practical results and difficulties of the voltmeter and ammeter methods, attention was next turned to the employment of the dynamometer-wattmeter as an instrument for the measurement of the power given to the primary circuit of transformers. There is no need to recapitulate well-known facts about the use of such an instrument for this purpose. It is well understood that a wattmeter or dynamometer with independent series and shunt coils can be used for this purpose, provided that the shunt circuit has a practically zero time constant, and the only difficulty which presents itself in passing an opinion on the suitability of any particular two-circuit dynamometer for this purpose is that of knowing whether the shunt circuit really *is* practically so far free from sensible inductance or capacity as to make this the case—and this, as our experiments show, must not be taken for granted without investigation. Two wattmeter dynamometers were provided. The first consisted of a Siemens dynamometer of the usual pattern, intended to be used as an ammeter for currents of 0.2 to 4 ampères. The fixed coil consisted of a few dozen or so turns of wire, and the movable coil of four turns. We arranged the connections so that it could be used as a wattmeter, the fixed coil being the series coil, and the movable coil of four turns being put in series with 24 100 volt, 50-c. p. incandescent or also with two rows of 24 16-c. p. lamps arranged in parallel, and this arranged as a shunt circuit. Contrary to the usual practice we had then a wattmeter in which the shunt circuit carried the larger current. This circuit was traversed by a current of from 1.8 to 2,94 ampères when placed across 2.400 volt mains, according to the group of lamps used.

This dynamometer-wattmeter had then a shunt circuit consisting of the 24 series of lamp filaments *plus* the four turns of wire on its movable coil. It had therefore a very small inductance. This wattmeter was calibrated by applying it to measure the known power taken up in our standard resistance. The six coils of our No. 1 resistance, each consisting of about 1,600 ohms, were arranged,

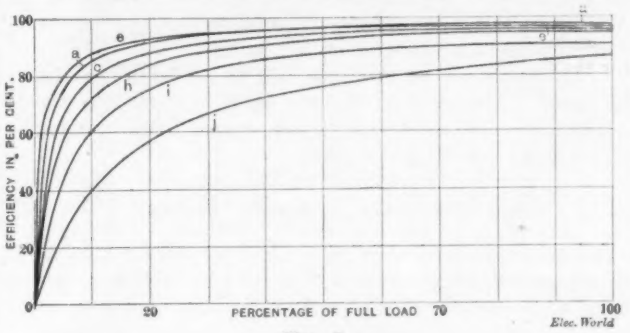


FIG. 7.

two in series and three in parallel, across 2,400-volt mains. The current through these resistances was measured by a Kelvin deciampère balance, and found to be 2.230 ampères; the P. D. between the mains was measured by the Swinburne voltmeter, and found to be 2,400 volts, and kept at that value by a regulating transformer, with carbon resistance on the secondary circuit (see Fig. 6); and from these measurements the power taken up in the resistance was known. It was 5,357 watts. The dynamometer wattmeter was then arranged so as to measure the known power being absorbed by this resistance, and the constant of the wattmeter thus determined. This constant was frequently determined. The value was close to 30.6 watts per division of the scale. It will be seen, therefore, that we were employing a wattmeter which, although it absorbed considerable power in its own shunt circuit, had a range of measurement from 12,000 watts down to about 10 or 12 as a minimum visible.

We found it essential to standardize the wattmeter on the largest power absorbing arrangement possible, so as to get the greatest possible wattmeter scale reading on a known power-absorption in determining the instrumental constant. For if a small power reading was taken, then any error in the scale reading was multiplied up in getting the watts corresponding to a larger scale reading taken from a value of the constant, and sensible errors introduced.

In addition to this instrument Mr. Swinburne provided two of his own non-inductive wattmeters. In this last instrument the shunt circuit consisted of a small bobbin of a good many (probably a hundred or more) turns of fine wire, having a resistance of about 300 ohms. In series with this externally, and forming part of the wattmeter shunt circuit, were two doubly wound wire resistances in brass

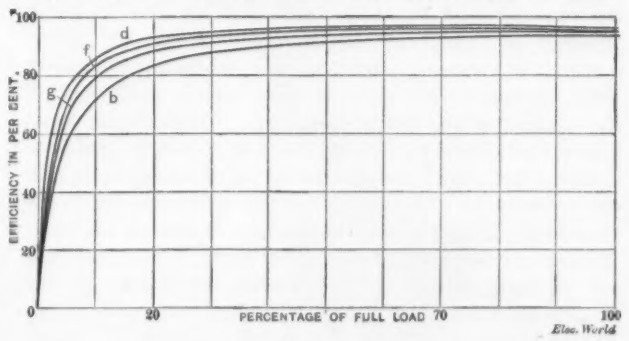


FIG. 8.

boxes, having a total resistance of about 100,000 ohms, assumed to be practically non-inductive. Provided with these wattmeters we proceeded to make a series of tests on various transformers of the power absorbed when the transformer was doing secondary work of various loads. The results are embodied in the series of tables below. In each case the Siemens dynamometer, called hereafter the "dynamometer-wattmeter," was standardized on the inductionless resistance when absorbing about 7 h. p., and then, having obtained the constant, its readings were taken when placed on the primary circuit of the transformer.

The transformers had gradually increasing loads of lamps put upon their secondary circuits, and while the power, W_1, supplied to the primary was measured by the dynamometer-wattmeter, that given up by the secondary, W_2, was measured by a Kelvin balance and electrostatic voltmeter placed on the secondary circuit. We measured also the primary current value in ampères corresponding to each definite load on the secondary circuit. We obtained, therefore, for every transformer, the volts, or P. D., across both terminals, the ampère current, and the watt output of the secondary circuit, and at the same time the ampère current and power absorbed in watts by the primary circuit; and hence the difference between W_1 and W_2, or the power lost in the transformer, is also known for each secondary load. Finally, also, the ratio of W_2 to W_1 in percentages can be calculated, and gives us the efficiency. In all these experiments the P. D. on the primary terminals was kept carefully constant at 2,400 volts, and the constant of the primary wattmeter checked at the beginning and end of each series of observations.

For each transformer was determined the currents and terminal potential differences corresponding to the various stages of secondary load from no load up to the full nominal output of the transformer, and at the same time the power W_1 given to the transformer primary circuit, and the power W_2 taken off from the secondary circuit. The "total lost watts," $W_1 - W_2$, and the efficiency, or ratio $W_2 \div W_1$, corresponding to each secondary load, were also calculated. From the known or measured value of the resistances of the copper circuits (taken when the transformer was warm) and the measured currents, we could calculate the copper losses (C^2R losses) in both circuits, separately and together, to the nearest integer, omitting fractions of a watt in most cases; and from the primary volts and current we obtained the value of the "apparent watts" given to the transformer at each stage; and from the "apparent" and "true" watts given to the primary circuit we could deduce the power factor corresponding to any secondary output. The values of the secondary terminal P. D. or volts gave us also the "total secondary drop" at each load, and from the resistances and currents could be found the "copper drop," or volts lost by resistance. The observations and calculations for each of the 10 transformers tested are given in full in Tables IX. to XXIX., inclusive, which sufficiently explain themselves.

[We give abstracts of these tables below, together with the "remarks" in § 13.—ED. E. W.]

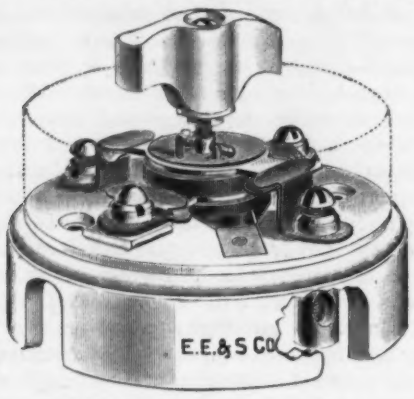
12. The results of these numerous observations are set out graphically, and thus represented to the eye, in a series of diagrams. For each transformer four diagrams have been prepared. The first shows the "total lost watts" curve, or $W_1 - W_2$, plotted as a curve in terms of the corresponding secondary output W_2; and on the same diagram is given a curve showing the total copper losses (C^2R) in the transformer in both circuits together. Hence the difference of the ordinates of these two curves gives the value of the losses other than those due to ohmic resistance in the transformer. The second diagram shows the value of the two currents, primary and secondary, plotted in terms of the secondary output. Since all the closed magnetic circuit transformers tested had a transformation ratio and windings in the ratio of 24 to 1, the primary current and 1-24th part of the secondary current are plotted together on the same scale. The third diagram gives the efficiency curve. The efficiencies in per cents., corresponding to decimal fractions of the full secondary output, are calculated from the "total loss" curve and then drawn. Hence they are all comparable, and we can see at a glance the percentage efficiency corresponding to loads of one-tenth, two-tenths, etc., of the full secondary load. The fourth curve is the "secondary drop" curve, and gives the "total observed drop," the "drop" due to secondary and to primary resistance, and the surplus or "leakage drop" due to leakage of induction, all plotted in terms of the secondary output. The efficiency values are tabulated in Table XXX., and graphically represented in Figs. 7 and 8, for the different fractions of full load for all the transformers.

TABLE XXX.—EFFICIENCIES OF TRANSFORMERS CALCULATED FROM CURVES OF TOTAL LOSSES, FROM OBSERVATIONS BY DYNAMOMETER WATTMETER.

Reference Letter.	Size and Description of Transformer.	Fractions of Full Secondary Load. 0	0.025	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		Percentage Efficiencies.												
a.	6,500-watt Westinghouse	0	61 8	75.9	85.7	91.9	94.0	95.1	96.0	96.3	96.6	96.8	96.9	96.9
b.	3,000-watt Swinburne	0	39.3	56.2	71.7	82.9	87.6	89 8	91.2	92.2	92.8	93 2	93.4	93.5
c.	4,500-watt Thomson-Houston	0	49.1	65.4	78.8	87.8	91.1	92.9	93.8	94.2	94.6	95.0	95.0	94.7
d.	20 h. p. (1892 pattern) Ferranti	0	62.0	76.6	86.5	92.6	95.0	95.6	96 1	96.5	96.8	96 8	96.6	96.6
e.	15-h. p. " " "	0	65.5	79.0	88.1	93.4	95.0	95.7	96.0	96.2	96.3	96.1	95.8	95.5
f.	15-h. p. " " " (rewound)	0	55.0	70.8	83.0	90.5	93.1	94.5	95.1	95.4	95.5	95.4	95.2	94.7
g.	6,000-watt Mordey	0	52.1	67.6	80.1	88.5	91.1	92 7	93.7	94.2	94.7	94.9	95.1	95.4
h.	4,000-watt Kapp	0	39.5	56 5	72.3	83.8	88.0	90.4	91.9	92.6	93.3	93.8	94.0	94.2
i.	5-h. p. (1885 pattern) Ferranti (rewound)	0	28.8	44 5	61.4	75.6	81.9	85.5	87.7	89.0	89 8	90.2	90.5	90.8
j	5 h p. " " "	0	14.6	25.3	0.43	57.2	66.5	72.5	76.4	79.1	81.5	83.1	84.5	85.5

Electric Engineering and Supply Company's Switch.

A close examination of this switch will show quite an improvement in this line of goods, and in the absence of many of the defects of its predecessors it will compare very favorably with them. The contact is made by rotating metal arms mounted on a spindle, insulated from each other, so that they pass between two metal contact pieces mounted on each of the four binding posts, so as to make a long wiping knife contact between the parts on both sides of the contact arms. In order to make and break instantly



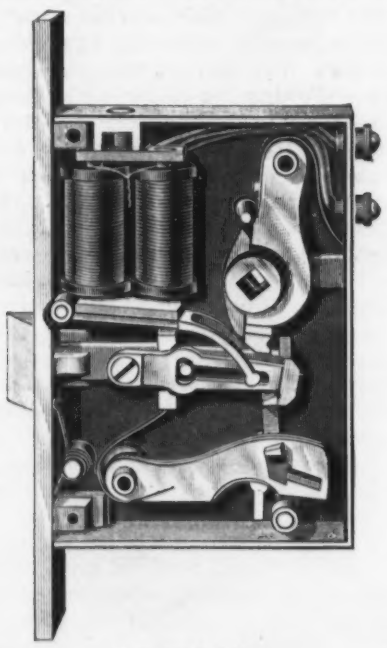
The E. E. & S. Switch.

there is arranged, in a recess in the porcelain base, two elliptic steel springs, which press against the sides of a square framework holding a roller in each of its corners, so that, in turning the handle, the square framework is rotated until the rollers on two of the corners have compressed the two springs, and are just passing the highest point when the contacts are about to be made or broken. Having passed this highest point, the springs press the rollers on the corners toward the centre so as to rotate the switch through the part of the circle in which it travels. Owing to lost motion left in the spindle there occurs instantly the make or break of the circuit with a sudden snap. The openings left in the side of the base facilitate surface wiring, so that the wires may pass directly into the binding posts, which are drilled in the side to receive the wires, which are held by a screw passed downwardly through the binding post, or, if preferred, the post is bored from the bottom up through the top and the wires held by a binding screw passing through the side of the contact post.

This switch is manufactured by Electric Engineering & Supply Company, Syracuse, N. Y.

A New Electric Lock.

Messrs. Wilkinson & Tinkham, 24 Beach street, Boston, Mass., are placing on the market an electric lock known as the W. & T. electric lock, which is claimed to have a num-



Electric Lock.

ber of advantages. It occupies a small space and is substantially made. It is impossible to leave the door unlocked, as the lock is never unlocked except when in circuit. It is claimed to work well, no matter in what position the latchbolt may be. It is made reversible, and can be used for either right or left hand doors. Each lock is adjusted so as to work on two cells of the Planté battery.

Australasian Cable Rates.

About a year ago the leading Australasian colonies entered into an agreement with the cable companies connected with the mother country, which enabled the latter to reduce their rates by 50 per cent., that is to say from eight to four shillings per word. Australasia, however, has been so severely hit by the prevailing commercial depression that the colonial governments have been obliged to diminish their contribution to the cable companies' revenue, and in consequence New Year's witnessed the raising of the rates to 4s. 9d. per word.

The Twin Arc Lamp: A Reply by the Electric Construction and Supply Company.

A Ward Twin lamp is the embodiment of two or more arc lamps in a single frame, with the necessary elements for operating the lamps successfully.

The arc lamp described in your issue of Jan. 14, by Mr. R. M. Hunter, and illustrated by a cut, is old—very old—and impractical. Expériments of this form, with a single mechanism, either hand or automatic, might have gained some notice ten or twelve years ago, but even then, as now, they ended in failure.

They will not succeed until some one discovers an electrode which will burn and make a gas arc path in air absolutely constant. This is considered an impossibility.

When the carbons are fixed, as shown by Mr. Hunter's illustration, two arcs cannot be made to maintain the same resistance when traversed by the same current in series across the two.

Two arcs are not two arc lamps. The error of calling an arc an arc lamp has been and is being made continually. A lamp cannot be called an arc lamp until it works and performs the functions of an arc lamp.

"The application of two arcs in a single lamp" cannot be called a twin lamp. A twin lamp is essentially the combination of two lamps in one frame, both burning successfully and simultaneously.

The Acme Storage Battery System.

On Wednesday of last week a trial was made, in the presence of representatives of the technical and daily press, of the storage battery system which is being exploited by the Acme Storage Battery Manufacturing Company, 29 Broadway, New York City, of which Mr. George C. Warner is president, Wm. N. Fletcher vice-president, and C. J. Griffith secretary and treasurer. The car was run from the stables at the corner of Fifty-third street and Ninth avenue, to One Hundred and Twenty-fifth street, and back. The most interesting feature of the trip was the action of the car in climbing the steep hill starting at One Hundred and Twenty-fifth street and running south, the grade of which is said to be six per cent. The car went up the hill in a very satisfactory manner, although at a low rate of speed on account of the bad condition of the track. It is claimed that during a test in charge of a well-known engineer, the car ascended the hill at a speed of 6.7 miles per hour.

The Acme battery is covered by the patents of Patrick Kennedy and Charles J. Diss, and its peculiar feature is the formation of the grids. These grids, which are shown in the accompanying illustration, are of a non-conducting material, which is not attacked by the acid, and which is sufficiently elastic to yield to

Figs. 1, 2 and 3.—The Acme Storage Battery.

the expansion of the active material without buckling, warping or breaking. On the other hand, the active material is retained with sufficient firmness in contact with the conducting plate of lead, which is situated in the middle of the complete plate. There is an equal amount of active material on each side of this lead conducting plate, thus insuring an equal distribution of current. Ribs on the non-conducting grids meet through slots in the conducting plate, and are cemented together, uniting the whole into one solid plate. The openings for the reception of active material are smaller on the outside to aid in the retention of their contents. The exposed surface of active material is about 40 square inches on each plate, or about 200 square inches for the five positives. The maximum steady discharge on the hill was 130 amperes, or about 65 amperes per square inch.

The Acme cell weighs 27 pounds, while a cell of the same dimensions using lead grids, it is claimed, would weigh 40 pounds. The inventors claim that this form of cell is practically indestructible, and will not deteriorate with time, while it will stand any amount of rough handling. The car is equipped with 144 cells, arranged in four groups. The controlling mechanism groups these sets either all in parallel, in two sets of two in series, three in series, or four in series, according to the speed desired.

The car is an ordinary 16-foot car, mounted on Baker trucks. It is equipped with a McDougall double reduction motor, rated at 20 h. p. This motor is the invention of Mr. W. M. McDougall, and has been before the public for the last two or three years.

This car has been in daily operation for the past three weeks, and is said to have run to the entire satisfaction of the promoters of this system.

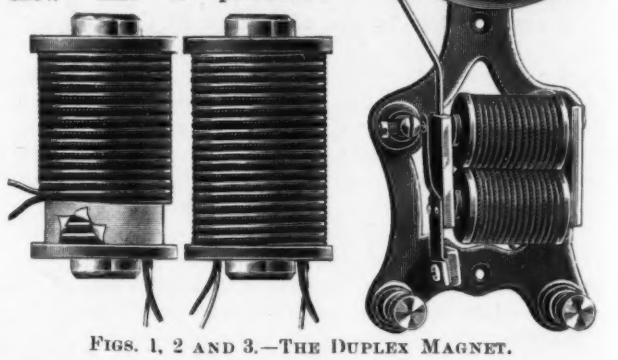
Another Three Phase Current Installation.

A Vienna journal states that a central station is about to be constructed in the town of Pergine, in which the three-phase current is to be used. The capacity of the generator will be 100 h. p., and it will be driven by a turbine at 600 revolutions and 1,000 volts. The distance to the town is about 1¼ mile. The current is received in four transformers of different capacities, and reduced in them to 100 volts for distribution. The installation is built by the Oerlikon Company.

Duplex Magnets.

The electromagnet in common use to-day is practically the same as that of the first magnet made. Various modifications have been suggested from time to time for the saving of both cost and space, but these have not proved feasible, or, at any rate, few changes have been made. Mr. Richard Varley, Jr., chief electrician of the Okonite company, has invented a method of winding magnets for which patents were issued on Jan. 3 of this year. This method has been christened the "Duplex," and is controlled by the Varley Duplex Magnet Company, 126 Liberty street, New York City.

The method consists in winding the magnet simultaneously with two wires, one of which is insulated and the other bare, so arranged, of course, that they alternate in position. Although this invention at first seems very simple, a little reflection will show that it possesses



Figs. 1, 2 and 3.—The Duplex Magnet.

a number of advantages over the method that is now in common practice.

In the first place, as only one-half of the wire is insulated, it is seen that there is a very material saving in the matter of insulation. As in certain sizes magnet wire costs 100 per cent. more than bare copper wire, this becomes an important factor, especially in all forms of universal apparatus, where large numbers of spools are employed. Secondly, as the bare wire has a considerably less diameter than a covered wire, the space occupied by the winding will be less and the length of the mean turn will also be less, which means that the same number of turns can be placed upon a magnet with a less total length of wire than in a magnet which is wound in the usual way. This is of course an actual saving in the amount of copper used.

Again, as considerable space is saved by the use of one-half bare wire, the magnet can be made more compact, which, in certain forms of apparatus, is a very important feature. As the strength of the magnet will depend solely upon the number of turns and the strength of the current, by this method it is possible either to obtain the same strength of magnet in a smaller space or a stronger magnet occupying the same space.

In winding Duplex magnets, it was found necessary to design a machine especially for the purpose, and this has been successfully accomplished by Mr. Varley, a model of which is at present in operation at the office of the company.

In the Duplex method, four ends are brought out instead of two, which makes it very convenient to connect these to form the combinations desired for any particular class of work.

This style of winding has thus far been applied only to the most universally used apparatus, such as bells, annunciators, telegraph and telephone instruments, etc. It is not intended for use with very high potentials, where the matter of insulation is of supreme importance, but in the apparatus mentioned the question of insulation is not a serious one, and the reduction of the insulating material will do no harm. In this class of instruments a saving in space is often very important, and the Duplex company looks for a wide application of its magnets in this direction. It is also proposed to extend this same style of winding to small motors and generators, and various other apparatus of that sort in common use.

In Fig. 1 is seen the magnet with the last layer nearly completed, and a portion of the paper which separates the layers torn away so as to show the layer underneath; Fig. 2 shows a completed magnet with the four ends coming out; while Fig. 3 represents an ordinary bell to which Duplex magnets have been applied, illustrating the compactness of this new method of winding.

A New Telephone.

The necessity of a telephone which can be used for short distances and which, at the same time, can be obtained at reasonable cost, has been keenly appreciated by thousands of business men, manufacturers and others, who, for various reasons, have found the telephone in general use unsuited to their purposes.

Many devices have been constructed for the purpose of meeting this demand, but, until recently, with only partial success. Letters patent have been granted within the past twelve months, however, to Mr. A. L. Simpson, of New York, for an acoustic telephone that is receiving hearty indorsement.

The new telephone in its present prefected state possesses many superior features for private lines of not more than two miles in length, and also for communicating from a central point with the different parts of large

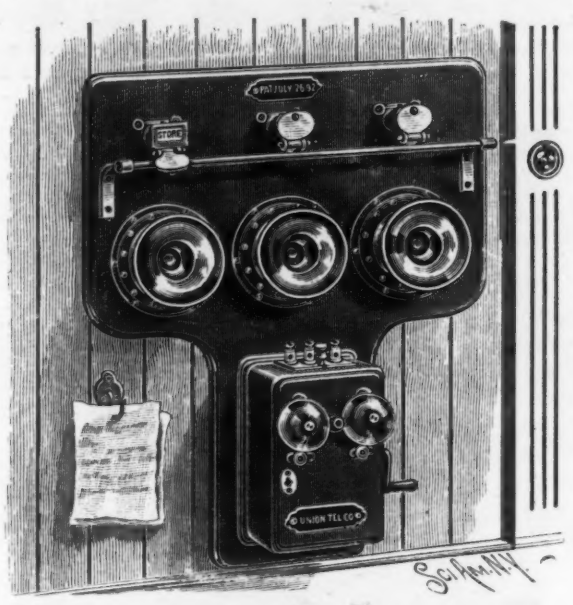


FIG. 2.—MULTIPLE ACOUSTIC TELEPHONE.

manufacturing establishments, public buildings, etc. Conspicuous among the advantages claimed for it are promptness and reliability of service, perfect articulation at all times and simplicity of construction. No electric batteries of any kind are used. The instruments are sold outright to those desiring to use them.

The different kinds of instruments are illustrated in the accompanying cuts.

Fig. 1 represents a telephone with upright mouthpiece, which is especially adapted to meet the wants of those wishing to place the telephone back from the window, or in any part of an office or hallway.

Fig. 2 shows the main board of the multiple-duplex system, which is to be used where several lines from different points are brought together. It will be seen there is a horizontal bar with annunciator drops over

FIG. 1.—THE SIMPSON ACOUSTIC TELEPHONE.

the top of each mouthpiece. When a party from a distant point desires to communicate, he simply rings his call bell, when the drop over the corresponding mouthpiece at the central board will fall, indicating exactly which line is being operated. On the other hand, if the party at the main board wishes to call any department, he throws the drop down by hand on the line which he wishes to speak over and rings the bell, when the party so called will be simultaneously notified, without disturbing any of the other lines.

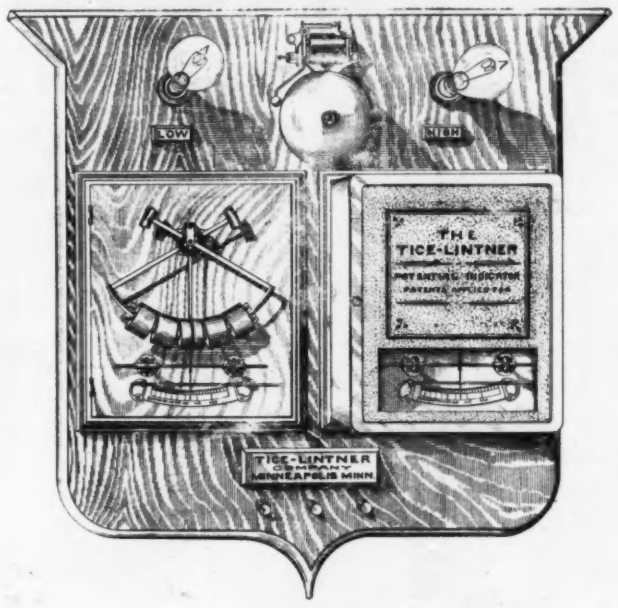
The telephone is manufactured by the Union Telephone Company, whose principal office is at Nos. 64 and 66 Broadway, rooms 43 and 44, where the telephones can be seen in practical operation and where further information may be obtained.

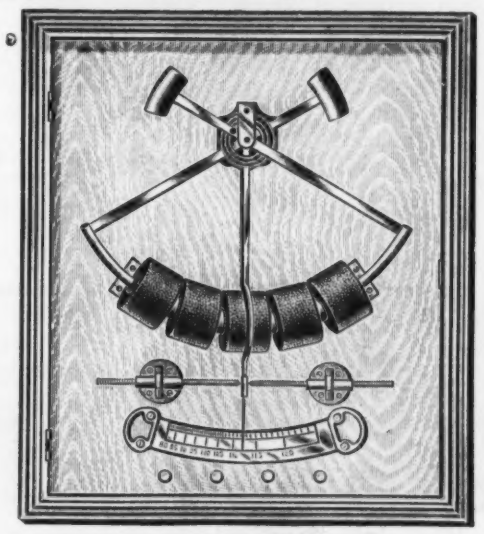
The Tice-Lintner Potential Indicator.

The Tice-Lintner Electric Company, of Minneapolis, has recently perfected and placed on the market an instrument which fills a long-felt want, and which will be a most valuable, and, it would seem, a necessary acquisition to every direct current plant.

Recognizing the necessity of close potential regulation, and believing that with more perfect regulation lamp breakage would be reduced to a minimum, the above company has brought out an instrument which combines with a voltmeter of the highest degree of accuracy, permanency and dead beat qualities an alarm attachment of equal reliability, which immediately attracts the attention of the attendant to any change or variation in pressure. Red and green lamps to indicate whether the pressure is high or low are provided and lighted simultaneously with the ringing of the alarm bell.

The indicator is now in successful operation in some





FIGS. 1 AND 2.—THE TICE-LINTNER POTENTIAL INDICATOR.

of the largest lighting plants in the country, and its introduction has been attended with a marked diminution in lamp breakage, as there can be no perceptible increase of potential without the dynamo attendant being immediately apprised of the fact, and the same remedied before any damage ensues.

This intensity of field results in the indicator being little affected by the close proximity of circuits carrying heavy currents, or by other similar agencies so troublesome to most measuring instruments. In its construction it has been the aim of the inventors to concentrate the action within the normal limit of the system on which it is placed, so as to give to the index arm the requisite degree of force essential to a circuit closing device.

Two delicately balanced armatures of the softest obtainable iron, to one of which is attached the index, are acted upon by the magnetic field of a curved solenoid in such a manner as to form opposite poles at their contiguous extremities, the mutual attraction of which greatly augments the directive force of the solenoid. This attractive force of the iron cores increases very rapidly as they approach, and diminishes as rapidly as they recede, thus giving to the instrument the greatest delicacy of action and securing wide range of movement to the circuit closing index arm for the slightest change of potential.

The alarm circuit, together with that of the signal lamps, is completed through one of the two platinum tipped contact points, set on either side of the index, and which are adjustable, by turning a milled head, to any desired range from a fraction of a volt up. If desired, the contact points may be removed to the extreme ends of the scale to permit of using the instrument as a voltmeter.

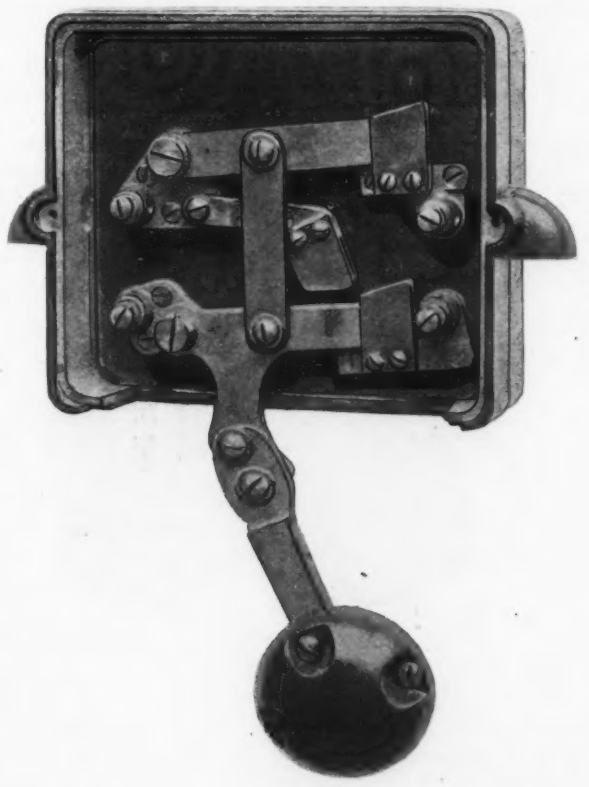
A general view of the instrument is shown in the accompanying illustrations, one of which represents the three-wire indicator with one of the ground glass covers removed.

The "Turbayne" Mast-Arm Cut-Out.

On account of the dangerously high potential that exists in the operation of arc lights which are used for street lighting, every possible precaution should be taken to prevent accident to the employees while engaged in a hazardous operation, such a one, for instance, as trimming or adjusting street lamps when the current is flowing, and, as is often the case, when the circuits are grounded and the earth is damp.

Lamp trimmers frequently receive dangerous, if not fatal, shocks, which often result in lawsuits, but all danger could be eliminated if a proper cut-out device was placed in connection with each lamp and arranged in such a manner that, when the lamps were lowered for trimming, they would be absolutely disconnected from the circuit.

Several good forms of these cut-outs are already on the market for use in connection with rope-suspended lamps, but none seems to have been devised for the equally, if not more important use, on mast arms, and



FIGS. 1 AND 2.—THE TURBAYNE MAST-ARM CUT-OUT.

so arranged that the lowering of the arm automatically cuts the lamp out of circuit. For the above purpose there has been devised the arrangement known as the "Turbayne" mast-arm cut-out, and the accompanying illustration will show at a glance its method of operation.

It consists essentially of a two-way switch, to the insulated lever of which is attached a pendulous weight, and an iron weatherproof casing, to the back of which, and cast integrally therewith, are the bases of the clamps used for connection with the mast arm. The electrical connections are massive and substantial and no sparking occurs when making or breaking the circuit.

The article is manufactured by the Turbayne Electrical Specialty Company, of Detroit, and any information regarding same will be gladly given by them.

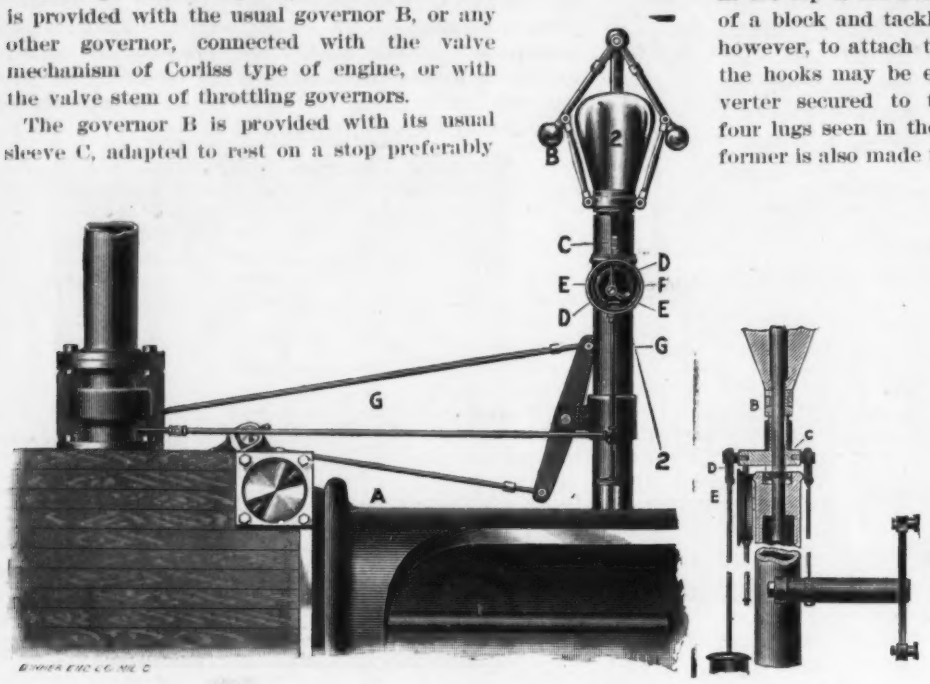
Automatic Safety Stop as Applied to Corliss Engines.

The object of this invention is to provide a new and improved safety stop for engine governors, which is simple and durable in construction, very effective and automatic in operation, and arranged to permit the governor, in case of accident, to drop sufficiently to throw the cam on the knock-off levers into action to prevent the cylinder from taking steam.

The invention consists of a stop controlled by the motive agent of the engine, and adapted to support the governor sleeve when the motive agent is shut off. Fig. 1 is a side elevation of the improvement as applied. Fig. 2 is an enlarged transverse section of the same on the line 2-2 of Fig. 1.

The engine A, of any improved construction, is provided with the usual governor B, or any other governor, connected with the valve mechanism of Corliss type of engine, or with the valve stem of throttling governors.

The governor B is provided with its usual sleeve C, adapted to rest on a stop preferably made in the shape of a lever d, when the steam is shut off by the engineer. When, however, an accident happens to the governor, while the engine is running, the stop D, being from under the sleeve C, permits the governor to drop sufficiently so as to completely shut off the steam from the engine.



FIGS. 1 AND 2. SAFETY STOP FOR CORLISS ENGINES.

It is understood that the stop lever D supports the sleeve when the steam is shut off by the engineer closing the valve, then the valves of the engine are still in position to take steam as soon as the engineer again opens the valve to start the engine. This stop lever D is controlled by the motive agent, and for this purpose the following arrangement is made. The lever D is fulcrumed within a casing E, attached to the support of the governor, as plainly shown in Fig. 1. The lever D is provided with an extension pivotally connected by a link with the closed end of a spring tube F, preferably bent in the shape of a segment of a circle, as plainly shown in Figs. 1 and 3.

The spring tube F is arranged within the casing E, and is connected at its open end with a pipe G, leading to the supply pipe or other part of the steam chest, so that the motive agent can enter the said pipe G whenever the valve controlling the inlet of the steam through the inlet pipe is opened.

Now, it will be seen that when the motive agent passes through the pipe G into the tube F, the latter swings outward at its free end, as shown in dotted lines in Fig. 3, thus exerting with this free end a pull in the extension of the lever D, whereby the latter swings from under the sleeve C, to permit the latter to drop below its normal position in case of accident to the governor. As soon as the motive agent is cut off from the pipe G, by closing the valve in the inlet pipe to the cylinder, then the tube F is relieved of the pressure of the steam and consequently its free end contracts so as to move the lever D back to its normal vertical position as illustrated in Fig. 3, to support the sleeve C in a normal position.

Now it will be seen that while the engine is running the lever D is swung from under the sleeve C by the pressure of the steam in the spring tube F, so that in case of accident to the governor B, the latter can drop sufficiently to throw the cams on the knock-off levers into action, so that the steam hooks cannot catch and open the valves, thus cutting off the steam supply and thereby stopping the engine.

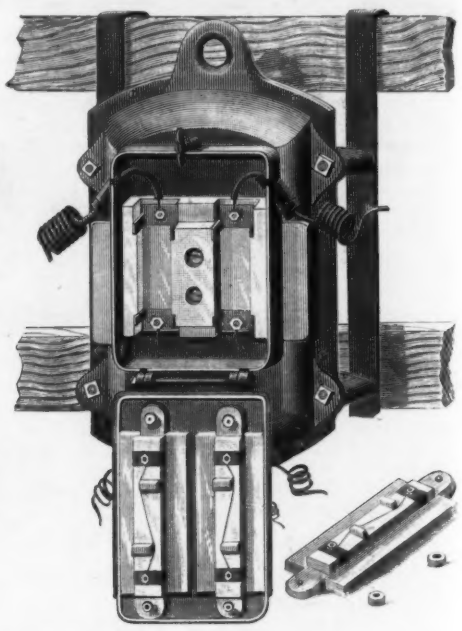
When the engine is running normally and the lever D has swung from under the sleeve C, as above mentioned, and the engineer shuts off the steam from the supply pipe, then the lever D swings back into its normal position before the engine comes to a stop, so that the lever D is ready to receive and support the sleeve C, thus holding the governor in the proper position for starting the engine.

This apparatus is manufactured by the Sioux City Engine Works, of Sioux City, Ia.

The Diamond Transformer.

The Diamond transformer is the latest type which has been placed on the market and embodies, it is claimed, all that experience has obtained from the good qualities of other converters, while it succeeds in evading all of their defects. A transformer to be popular in these days, with the superintendent of central stations and with linemen, must be convenient and unattended with any abnormal difficulties in placing it upon poles or buildings.

Fig. 1 illustrates the transformer as it appears when attached to the cross-arm. It will be seen that this converter is easily adjusted and held in secure position by the hooks engaging with the cross-arms. The ring in the top is for hoisting upon a pole by means of a block and tackle. Should it be necessary, however, to attach this converter to brick walls, the hooks may be easily removed and the converter secured to the wall by means of the four lugs seen in the cut. The Diamond transformer is also made three-point, and is easily and quickly convertible from 50 to 100 volts on the secondary wires without the use of a switch.



FIGS. 1 AND 2.—THE DIAMOND TRANSFORMER.

Fig. 2 shows the transformer with fuse box exposed to view. The primary and secondary connections are readily seen, and it will also be noticed that when the door is closed each fuse is in a separate compartment, so that in case one should blow out it would have no effect upon the other by excessive heating. The porcelain box and fuse blocks are highly glazed, and it is claimed that there is no danger of their absorbing moisture. The convenience of this style of fuse box will, we believe, be apparent. The fuse blocks are attached to the door itself. It follows that when the door is opened the connection is completely broken, and a lineman may replace fuses upon a live wire with perfect safety, at the same time having the fuse blocks entirely exposed to view. The fuse blocks themselves may be detached by means of a little gnarled thumbpiece, seen by the side of the detached block. The fuse blocks are interchangeable for all sizes of transformers, so that a central station, by keeping a few of them on hand, may always be assured of a fuse block in case one upon the line should be broken by lightning or otherwise.

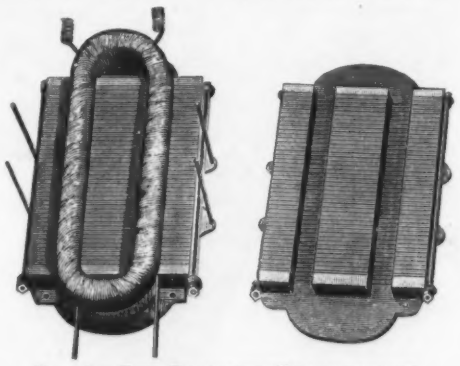


FIG. 3.—THE DIAMOND TRANSFORMER.

It has been a source of inconvenience and expense to central stations heretofore to return burned-out converters to their respective factories to be repaired or replaced. The delay has often caused serious inconvenience, and it has resulted in many cases in the larger stations making ineffectual attempts to repair the converters themselves.

Fig. 3 illustrates one of the most important claims of the Diamond converter to the appreciation of practical central station men. It will be seen that the secondary coils are in two parts, the primary coil being securely imbedded between the two, thus affording a common centre of magnetism. After the primary coil is in position, the secondary coils are adjusted and firmly bolted together, completing a perfect magnetic circuit. Should, however, a primary coil be burned out by lightning or otherwise, it is only necessary to have another coil sent by express, when the central station man can readily place it in position himself, thus obviating all the delay and expense which was a necessary part of the old methods.

The Diamond converter is of very high efficiency, low leakage current and excellent regulation. It is made as light in weight as is consistent with the best practice, and is well ventilated through the top and bottom of the case, so that a free passage of air will aid in keeping the coils at a low temperature.

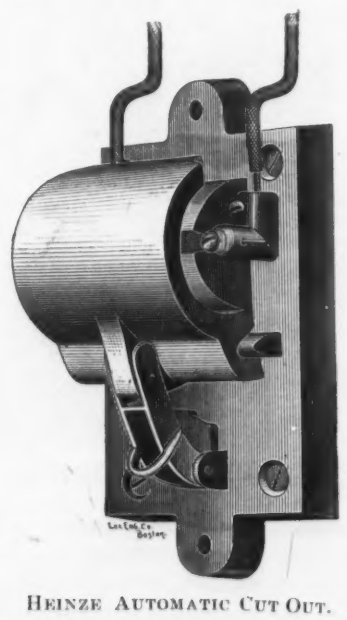
Taylor, Goodhue & Ames, 827 Monadnock Block, Chicago, Ill., have taken the exclusive agency for the sale of this converter, and have in course of preparation a pamphlet treating quite extensively of its merits.

A Most Novel and Useful Souvenir.

We are in receipt of a most novel and useful souvenir from the Mather Electric Company, for which we are at a loss for a sufficiently comprehensive name. A handsome morocco easel or stand about six inches square has in its upper left hand corner a small almanac. Directly below this is a miniature clock of the Ansonia Clock Company's make, about the size of a gentleman's watch. These two occupy the left hand half. The other half is occupied by a removable porcelain slate for memoranda. By means of these three one can tell the hour and the day, and be reminded at the same time of any appointment he may have. We do not recollect of having seen anything before in this line that was so elaborate, so pretty, and at the same time so useful, as this tasteful memento of the Mather Electric Company. With this, also, came their New Year's greeting, which we also appreciate and reciprocate.

Heinze Electric Co.'s New Porcelain Automatic Fuse Cut-Out.

The base, cover and cap are entirely made of porcelain. Fixed upon the base, at the outside of each porcelain projection, are binding posts, to which the main wire is attached, and also the fuse wire spanning the binding posts upon which rests the porcelain cap. At the moment the current becomes of abnormal strength, the fuse wire melts, establishing an arc, allowing the cap to fall into the space formerly occupied by the fuse wire and arc between the projections, whereby the length of the arc is increased, and the area through which it passes is decreased, which results in an increase of resistance, decrease of current and the breaking of the arc opening the circuit.



HEINZE AUTOMATIC CUT OUT.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Jan. 14, 1893.

NEW YORK GENERAL FINANCIAL STOCK MARKET.

As was predicted by us last week in the face of the improved monetary conditions, reflected in the falling off in gold exports and the improved bank statement, the market of the past week possessed an advancing tendency. The movement started on Monday, and although the fluctuations were over a comparatively wide range, the closing to-day was on a much higher plane, very firm, and indicates a still better market for next week. There were no gold shipments. Although sterling exchange has been firm, ranging dangerously near the exporting point, the present ease of money creates a belief that there will be little or no yellow metal taken for next week's shipment. The bank statement shows an increase in surplus reserve over last week of $6,668,000. This on top of an increase in net deposits of $7.502,400 is regarded by Wall Street as most favorable indications that money will be easy. Money ranged to-day at 4 and 5 per cent. for 30 and 90 days, and 5 to 5¼ per cent. for longer periods. Rates of exchange on New York have generally risen throughout the West and Northwest, a premium ruling at all points. The net earnings of 132 railroads for 1892 were $563,500,000, a net increase of $28,250,000. The largest gain in gross for the year were shown by St Paul, $3,488,773; Atchison, $2,815,530; Great Northern, $2,002,401; Missouri Pacific, $1,769,065; Rock Island, $1,658,341; Louisville, $1,573,319; New York Central, $1,326,827; Canadian Pacific, $1,154,127; Lake Shore, $1,018,614.

NEW YORK ELECTRICAL STOCK MARKET.

With one exception, every active stock in this list of specialties advanced during the week, closing very firm at the highest prices. Moreover, the list can be said to have been in the van of the movement, scoring at every step. It has been said of the general market that it was largely one of professional manipulation. We do not believe that this is true of the electrical stocks. Their movement was too steady and persistent, and the ground gained too firmly held to permit the belief that the sales were washed. It is generally conceded that the majority of the orders are for investing purposes. We note the continued inquiry for the high priced telegraph stocks, which has been manifest for a month, and which has met with no sales. There was a hardening of Commercial Cable from 170 bid and 180 asked, to 175 bid and 185 asked. North American showed a little strength, making a net gain of one point for the week, closing at 11⅛. American Telegraph and Cable sold as high as 88, an advance of 1½ points. This was due to the strength of the Western Union, by which it is leased.

Western Union.—To-day the stock reached the highest point in its history, viz., 99⅛. It reacted, closing at 97⅞. It will be remembered that on the advance three months ago it went to 95⅛, but that was in discount of the 10 per cent. stock dividend, which has since been paid. Buying was very persistent, and much of it for investment. The bonds were in good demand, the fives selling at 103⅛ to 104, a slight advance over previous quotations. A small lot of debenture sevens, the first which has made its appearance for some time, sold at 112½.

Robert Goodbody & Co., in their weekly letter, say: "Western Union has been strong, the idea of the bulls being that Mr. Gould's death has greatly increased the confidence of investors in the property, and no doubt this is true. One thing seems certain, namely, that American Cable stock is intrinsically a cheaper investment than Western Union stock, as it pays the same dividend (five per cent.) as Western Union, and this dividend is guaranteed by Western Union for nearly 40 years to come. Yet Western Union has a value as a speculative counter and there is no speculation at all in American Cable."

A daily contemporary says: "The feeling on Western Union continues bullish, and predictions are made that it will in the early future cross par. It is said the stock is being gradually absorbed by the Drexel-Morgan interests, and that before long an announcement will be made that will not alone have a beneficial effect on the market price, but will make it a gilt edged security for the investor."

General Electric.—We prophesied last week that this stock selling at 111 would reach a point within a fraction of 114 on Thursday. Facts have verified the prediction, the price being 113⅜. On the day following it sold ex a 2 per cent. dividend at 111¾ to 112½, and to-day sold up to 113, which is equivalent to 115, or a 4 point advance on the week's transaction. It was only moderately active. With a favorable market we look for a still further advance during the remainder of this month. The bonds were in excellent demand, selling at 100¼ to 100⅝. On Dec. 1, 1892, the General Electric Company had contracts with twenty-nine street railways for 986 motor cars. The largest contracts were with the Brooklyn City Railway Company, for 340 motor cars, and the Buffalo Railway Company for 100 motor cars. The Lynn & Boston Railway Company is still under contract for 180 motor cars. There are in all 411 street railways in operation and under contract using the General Electric system. The total number of the company's cars for roads in operation and under contract is 9,484, and total miles of tracks in operation is 4,767.40. The West End Street Railway Company of Boston is operating electrically 148 miles of track, and using 1,028 Thomson-Houston motor cars.

Edison Electric Illuminating of New York.—The course of this stock during the week surpassed all previous records, reaching 121. We have repeatedly stated in this column that the buying was in anticipation of the showing on the year's business. The directors met this week and audited the year's accounts. Next Tuesday they will hold an annual meeting, at which the report will be submitted. For the year ending Dec. 31 1891, this company showed net earnings of $347,288. Out of this was paid dividends of $155,989 and other fixed charges, leaving a surplus for the year of $21.785, and a total surplus of $61,006. The year just closed has been a prosperous one in the history of the company. An executive officer informed an ELECTRICAL WORLD reporter that the net earnings will show an increase of about $100,000 over those of 1891, given above. The bonds had an advance in sympathy with the stock, it being from 114½ to 117.

American District Telegraph.—The controversy which has been waged for some time between this company and its patrons, involving the monthly rent of 50 cents for the use of call boxes, has taken another turn. The company has decided to give the use of boxes free to those from whom they derive a yearly revenue of $25. All others will be expected to pay the 50-cent rate.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Jan. 14, 1894, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American District Tel....	100	3,825,000	5 ½	56½	56	59
American Tel. & Cable..	100	14,000,000	85½	88	87	88½
Central & So. Am. Tel....	100	6,500,000	....	....	110	120
Commercial Cables.....	100	7,716,000	....	....	175	185
Gold Stock & Tel.....	100	5,000,000	.	....	100	103
Bonds.....	500	500.000	....	....	100	....
Mexican Telegraph.....	....	2,000,000	....	....	180	200
Northwestern Telegraph.		2 500,000	....	....	102	....
Postal Tel. & Cable.....	...	10,000,000	...	....	62	64
Southern & Atlantic Tel..	25	948,775	....	....	78	84
Western Union Tel.....	100	94,820,000	95⅝	97½	95	96½
Real estate bonds.....	1,000	1,219,000	....	....	....	..
Debenture bonds.	1,000	1,920,000	112½	112½	....	..
Collateral Trust 5's....	1,000	8,181,000	103½	104	....	
North American.....	100	39,767,200	10½	11⅛	10½	11
Brush Ill. Co. of N.	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y.....	100	6,100,000	116½	121	119½	121½
" " 1sts.....	...	... .	114½	117	...	.
" " Deb's....	...	....	....	....	...	....
Edison El. Il. of Brooklyn.	100	1,500,000	...	....	106	108
" " " " Chicago..	100	750,000	....	....	130	145
" " " " Boston...	...	.....	....	....	115	125
Edison El. Lt. Europe....	1,000	2,000,000	....	....	2	6
" Bonds....	....	30,000	....	....	65	80
Edison Ore Milling Co....	...	2,000,000	....	....	15	20
East River El. Light.....	100	1,000.000	...	....	....	65
General Electric	1,000	30,395,600	*113¾	113	112⅛	113
Debenture 5's	...	10 000,000	100¼	100½	....	....
Automatic Exhibition Co.	...	2,500,000	..	....	3	5
Mt. Morris Electric.....	...	500,000	....	....	....	65
N. E. Phonograph.....	..	2,000,000	....	....	2	4
N. Y. Phonograph	...	2,000,000	....	....	2	5
N. American Phonograph ..		2,000,000	....	....		2.25
Westinghouse E. & M. Co. 1st p. 7 per cent., Cum.	50	3,755,700	....	....	....	....
E. & M. Co. Assg.....	50	5,333,940	....	....	....	....

* Ex-dividend.

WALL STREET NOTES.

The Edison General Electric Company has declared its quarterly dividend of 2 per cent. payable Feb. 1, 1893. Transfer books close Jan. 14 and reopen Feb. 2

The copper market has weakened perceptibly in a week under the rather free offerings of brokers, who are supposed to be acting for one of the large producers. On the Metal Exchange Friday, spot copper was bid 11.90 cents, and held at 12.10 cents; February futures were 5 cents higher. Actual market prices in carload lots are 12.20. The tendency of the market seems to be downward, and the consuming faction believes that still lower prices will rule. The Lake companies, generally speaking, are holding nominally at 12½ cents, although it is known that they are making sales to the majority of customers at 11¼ cents.

A quarterly dividend of $1.20 share was declared on Thomson-Houston common stock, payable Feb. 1, to stock of record Jan. 14.

The Buffalo & Tonawanda Electric Railway was incorporated Thursday with a capital of $100.000.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stocks furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago		209	Chicago Arc Light & Power Co.....	106½	108
Central Union		58	Chicago Edison Co ..	175	....

NEW INCORPORATIONS.

The Star Electric Company, of Dubuque, Ia., which was recently incorporated with a capital of $100,000, has obtained the time contract for lighting that city.

The Effingham Electric Light and Power Company, of Effingham, Ill., capital stock $15,000, has been formed to furnish light and power. Edward Austin, Calvin Austin and Dennis Bushor are the incorporators.

The Oreville Light, Heat and Power Company, Oreville, O., capital stock $20,000, has been formed to furnish electric light, heat and power. J. A. Wagner, David King, G. W. King, Jno. W. Wagner and J. P. Wagner are the promoters.

The Durango Light and Power Company, of Durango and Denver, Colo., capital stock $200,000, has been formed to erect a gas and electric light plant in Durango. The organizers are Clinton Reed, Sam P. Rise and E. R French, all of Denver.

The Inter-state Electric Light and Power Company, of Colorado Springs, Colo., capital stock $100,000, has been formed to operate and maintain electric power, plants, machinery, etc. S. H. Horner, Jno. W. Nyce and A. Q. Campbell are the promoters.

The Burton Electric Company, of Albany, N. Y., capital stock $10,000, has been formed to manufacture and sell electrical apparatus. Paul G. Burton, Howard Martin, of Albany, and C. P. Frey, of Greenbush, N. Y., are the parties interested therein.

The Great Western Manufacturing Company, Des Moines, Ia., capital stock $1,500,000, has been formed to manufacture, buy and sell electrical goods and appliances, wire, etc. The incorporators are Chas. E. Hunn, E. B. Fegan and Ely S. Hunn.

The Eastern Engineering and Construction Company, of Philadelphia, Pa., capital stock $500,000, has been formed to build and equip electric light plants, electric railways, etc. E. Knowles Perot, C. P. Perot, and W. C. Hannis, Philadelphia, Pa., are the promoters.

The Lancaster Electric Railway Company, Lancaster, O., capital stock $100,000, has been formed to build and operate an electric street railway. Frank Barrett, Andrew Bauman, Harry F. Becker, Henry B. Peters and Charles F. Nester are the incorporators.

The Lancaster & Marietta Electric Street Railway Company, of Marietta, Pa., captal stock $90,000, has been formed to construct, maintain and operate a street railway. Amos Bowman, James Duffy, and T. M. Grady, all of Marietta, are the organizers.

The Pocohontas Light and Water Company, of Pocohontas, Va , capital stock $100,000, has been incorporated to erect electric, gas and water works. R. S. Brock, G. L. Estabrook, Jr.; A. C. Denniston, C. E. F. Beemly and F. Chalmen are the parties interested.

The Petersburg Electric Light, Power and Water Works Company, of Petersburg, Ind., capital stock $10,000, has been formed to furnish light, power and water. G. Frank, Moses Frank, Solomon Frank, W. V. Hargrove and Chas. H Burges are the promoters.

The Girardville Electric Company, of Girardville, Pa., capital stock $5,000, has been formed to manufacture and supply light, heat and power by means of electricity to the public at Girardville. Moses Mervine, Albery Bordy and Wm. J. Yeo are the promoters.

The Frisbie Elevator and Manufacturing Company, of Chicago, Ill., capital stock $200,000, has been formed to do general manufacturing business, including elevators, electrical machinery, etc. Frank W. Parker, Emma Elliott and Chas. S. Burton are the promoters.

The Cloquet Light and Power Company, of Cloquet, Minn., capital stock $50,000, has been started to manufacture and sell electric lights, lines, poles, lamps, etc. W. P. Allen, F. B. Poole, A. M. Sheldon, Aug. Petersen and J. E. Lands, all of Cloquet, are the promoters.

The Green Bay & Fort Howard Gas and Electric Light Company, of Green Bay, Wis., capital stock $50,000, has been formed to build and operate a light and power plant. C. Collins, F. Hurlbert, H. P. Baker, W. A. Wagner and L. W. Hoffman, are the promoters.

The Commercial Light and Power Company, of Duluth, Minn., capital stock $500,000, has been formed to construct and operate plants, manufacture and deal in electrical appliances and fixtures. The promotors are G. A. Leland, M. Brooks, Duluth, Minn., and E Paine.

The Waterhouse Electric Company, Hartford, Conn., capital stock $20,000, has been formed to manufacture and repair all kinds of electrical apparatus and machinery, etc. Addison G. Waterhouse, F. G. Waterhouse and G. L. G. Waterhouse, all of Hartford, are the promoters.

The Cuyahoga Electric Company, Cleveland, O., capital stock $10,000, has been formed to furnish light, heat and power, and to deal in electrical appliances, etc. The organizers are N. S. Amstutz, Wm. R. Caulkins, Wentworth G. Marshall, Charles E. Ferrel and George G. Sowden.

The Vicksburg Electric Transit and Light Company, of Vicksburg, Miss., capital stock $2,000, has been formed to run a railway in the city of Vicksburg, and also to supply that city with electric lights. Chester R. McFarland, John J. Mulligan, and L. W. Magruder, all of Vicksburg, are the promoters.

The Everett & Snohomish Street Railway Company, of Everett, Wash., capital stock $100,000, has been formed to build, construct and operate railways, whether electrical, steam, or otherwise. T. Dwyer, R. M. Mitchell, W. de F. Edwards, Melvin Swartout, Jno. E. McManus, all of Everett, are the organizers.

The Central Colorado Electric Supply and Manufacturing Company, of Pueblo, Colo., capital stock $100,000, has been formed to deal in electrical goods and supplies of all kinds, etc Moses Franklin, E. H. McDermott, Boone Hartsor, R. McDermott, Thos. Neelson and H. W. Preston, all of Pueblo, are the promoters.

The Columbus & Harrisburg Electric Street Railway Company, Columbus, O., capital stock $15,000, has been formed to construct, lease, maintain and operate a street railway to be run by electric or other power. The promoters are James M. Briggs, Adam G. Grant, G. D. Martin, J. S. Young. J. H. Chenowith, Levi Hite and Geo. M. Stark.

The White Manufacturing and Construction Company, of Bayonne, N. J., capital stock, $100,000, has been formed to manufacture and deal in electrical and other articles for use on railways, etc. R. White, Brooklyn, N. Y.; W. W. Genet, Bayonne, N. J.; E. W. Dewey, New York City, and A. R. Genet, of Oscawana, N. Y., are the organizers.

The New York & Brooklyn Automatic Construction Company, of Jersey City, N. J., capital stock $100,000, has been formed to construct and build systems, devices, etc., above and below ground for the purpose of rapid transmission by electricity. T. C. Clarke, C. Roosevelt, E. Norton, New York City; J. M. Clancy, H. Z. Joy, Brooklyn, N. Y., and N. L. McElligott, East Orange, N. J., are the promoters.

AFFAIRS OF THE COMPANIES.

The Bishop Gutta Percha Company's Stockholders at a meeting held Jan. 11 elected as directors of the company Samuel Boardman, H. E. Blitz and A. Spodane. At a meeting of the directors held immediately afterward Samuel Boardman was re-elected president of the company, G. A. Blitz vice-president, and Henry A. Reed treasurer and secretary.

The Shippensburg Electric Light Company held its annual meeting of stockholders Jan. 9, 1893, and re-elected the old board of directors, the officers of which are J. C. Rummel, President; J. C. Fleming, Secretary; Clarence J. Reddig, Treasurer. The report of the treasurer was very encouraging, the company now having 850 incandescent and 19 arc lamps in use, and a demand for a commercial arc circuit will require a number of arcs for low ceilings. The company is to be congratulated on its progress, as it has been in operation only two years.

Minneapolis, Minn.—An application was filed here yesterday for the dissolution of the Edison Light and Power Company. The total number of shares issued and now outstanding is 4,895 of $50 each. The property and assets consist of real estate and building thereon and the electrical plant. The total indebtedness is $200,000. The petitioners and shareholders are: Northwest General Electric Company, 3,889 shares; H. M. Byllesby, general manager, 980 shares, and Howard C. Lewis, C. H. Maxey and H. C. Akely, one share each.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Jan. 16, 1893.

The Automatic Despatch Company Applies for a Franchise.—At a meeting of the Board of Aldermen this week a resolution to grant a franchise to the United States Automatic Despatch Company to lay a conduit in Park Row, from the postoffice to the entrance of the Brooklyn Bridge, was introduced and referred to the Committee on Streets.

President Austin Corbin, of the Long Island Railroad Company, has presented a petition to the Brooklyn Board of Aldermen asking for permission to construct an elevated road on Atlantic avenue, on the routes laid down by the Chapin Rapid Transit Commission in 1889. The Atlantic Avenue Elevated Company, of which Mr. Corbin is also president, was organized two years ago but litigation has delayed the building of the road. The Court of Appeals recently decided the suit in favor of the company. The petition was referred to the Aldermanic Committee on Railroads.

The Electric Club to Dissolve.—The Electric Club, which at the time of its incorporation some six years ago was the most novel social organization, is about to disorganize. Mr. Geo. M. Phelps, treasurer, has been appointed receiver, and Chief Judge Daly, of the Court of Common Pleas, has appointed Stephen H. Olin as a referee to hear objections to the dissolution of the club on April 20, 1893. The club house is at 17 East Twenty-second street. During the early days of the club it was well supported, but the novelty after a while wore off, and it is understood that its present revenue is entirely insufficient for its support.

PHILADELPHIA NOTES.

Branch Office of The Electrical World,
Room 31, City Trust Building, 927 Chestnut St.,
Philadelphia, Pa., Jan. 14, 1893.

Mr. C. S. Solomon, agent for the Mather Motor Company, 1015 Sansom street, Philadelphia, reports business very good, much above the average.

Mr. Percy Taylor, of the Priestman Engine Company, has been absent from his office for the past day or two consequent on a slight indisposition.

Geo. W. Lord, manufacturer of the well known boiler compound, 316 Union street, Philadelphia, reports business exceedingly good. One of the large orders recently received was from Magie Bros., manufacturers of lubricating oils, Chicago. This firm has ordered a carload of this boiler compound, which is a duplicate order.

Partrick & Carter, electrical supply dealers, Philadelphia, Pa., do no construction work, and therefore do not come in competition with their trade. On the contrary they make every effort to assist their customers in obtaining contracts, having on file in their office a list of contemplated building operations in all sections of the country requiring electrical work.

The American Silk Manufacturing Company still continues to obtain new customers for its silk wipers. The Philadelphia Fire Underwriters' Association has adopted these wipers in place of cotton waste, heretofore used by them. Other orders are from the Edison General Electric Company, Schenectady, N. Y., and Watervliet Arsenal Company, West Troy, N. Y.

W. C. McIntyre & Co., manufacturers of the "Crown shade" for incandescent lamps, have recently received several large orders, one of which is from a New Orleans firm for 500 shades. A very pleasing feature is the fact that every customer who had given an order on trial has invariably duplicated it. The flattering testimonials received by the manufacturers would thus indicate that this shade fully meets with all the requirements for which it is intended, and is destined to have an enormous sale.

PITTSBURGH NOTES.

Pittsburgh, Jan. 14, 1893.

The East End Electric Light Company has declared a quarterly dividend of 1½ per cent. to be paid on the 15th inst.

Pittsburgh Electric Club Lectures.—On next Saturday night a series of lectures will commence at the rooms of the Pittsburgh Electric Club. The subject on this occasion will be "The Mechanical Theory of Electricity and Magnetism" and the application of this new theory to the conversion of heat into electricity. The lecture will be given by Mr. L. J. Le Pontois, of the Westinghouse Electric and Manufacturing Company.

Annual Report.—At the annual meeting of the stockholders of the Pleasant Valley Street Railway Company Jan. 11, the following directors were elected: R. H. King, O. P. Scaife, William Roseburg, William H. Graham, Samuel C. Grier, Jas. Hunter, William T. Lindsey, and John P. Ober. A brief summary of the financial statement for the year ending Dec. 31, 1892, shows: Gross receipts, $400,906.61; operating expenses, $276 752.24; net earnings, $121,154.37; passengers carried during the year, 8,018,132, and total mileage run, 1,600,000 miles.

Aluminium Process Patent.—Word was received in this city yesterday that in the United States District Court of Cleveland, O., a decision had been handed down in the case of the Cowles Electric Smelting Aluminium Company, of Lockport, N. Y., against the Pittsburgh Reduction Company, of this city. The case involved the right as to the exclusive manufacture of aluminium by electric smelting, which by this decision is conceded to the Pittsburgh company, giving it a monopoly of aluminium manufacture by this process in America.

Street Railway Plant Idle.—A peculiar condition of affairs exists in the little town of Braddock, about eight miles from this city, where, by a decision of the Supreme Court, an electric street railway company has been obliged to suspend operations. The result is that the people are obliged to walk and the street car company has its plant idle. The cause of this trouble is that the street railway company laid its tracks across those of the Pennsylvania Railroad Company, to which the latter corporation objected and brought a suit, which resulted in this decision.

Repairs Quickly Made.—A fire occurred in the electric lighting plant of Allegheny City last Sunday morning, which for a time caused the greater part of the streets to be in darkness. Two dynamos were destroyed, but within a few hours after the fire the Westinghouse Electric and Manufacturing Company had furnished two new machines, an incandescent and an arc light machine, and on Sunday night the plant was in operation, as if no fire had taken place. Too much credit cannot be given to Mr. Hunter, the chief of the electric light station of Allegheny, for the promptness and energy he displayed in expediting the matter of getting his plant in shape so quickly after the operation had been so seriously impaired by the fire and water.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Jan. 11, 1893.

The American Electric Works, Providence, R. I., is sending out a very fine calendar.

The Newton Rubber Company, Boston, Mass., has issued a handsome calendar, very attractive in design.

The Massachusetts Electrical Engineers and Mechanics Association will hold its third annual ball at Odd Fellows Hall, Boston, Mass., Jan. 30, 1893.

The Wichita Electric Railroad has been sold by the sheriff under a mortgage of $300,000. The property was bought in by the bondholders, capitalists of Boston, Keene and Nashua, N. H.

Mr. George D. Burton, on Dec. 22, 1892, delivered an interesting lecture on "Heating and Working Metals by Electricity," before the Society of Arts at the Institute of Technology, Boston, Mass.

William Fenton & Co., of Glasgow, Scotland, manufacturers of Scandinavia patent cotton machine belting, have opened an office at 180 Summer street. This belting is specially adapted for dynamo use.

Removal.—The New England office of The Electrical World has been removed from room 28, Hathaway Building, 620 Atlantic avenue, to room 91 in the same building, where it will occupy more spacious quarters.

The Curtis Regulator Company has consolidated with the D'Este & Seeley Company, of this city, and will still be found at 29 Haverhill street, where it is now fitting up the building which, when finished, will be very complete.

The Selma Photo-Electric Manufacturing Company has recently started in the manufacture of mechanical electric bells at the corner of Commercial, Atlantic avenue and Lewis street. Mr. Carl L. W. Nelson is president, Edward A. Rosendahl Secretary.

Mr. Edw. C. Lewis has established himself at 154 Franklin street, Boston, and will give his attention to electrical engineering and will also do a general construction business. Mr. Lewis formerly had charge of the Holtzer-Cabot Company's construction department.

Mr. Harold Summer Geer, the popular representative of the Eddy Electric Manufacturing Company, was married Jan. 5 to Miss Blanch Maud McPhail, both of Boston, Mass. The many friends of Mr. Geer will undoubtedly be pleasantly surprised by this announcement. We extend our best wishes.

Mr. Thos. H. Bibber, the general manager of the American Magnetic Electric Company, Boston, Mass., has just returned from a trip West, and reports the outlook for business exceedingly good for magneto-generators, bells, etc. The company recently shipped a large order to Demerara, British Guiana, South America.

Chas. W. Holtzer, of Boston, has brought suit for an infringement of his patent covering the manufacture of carbons for batteries. By Mr. Holtzer's process the cover and the body of the carbon integral are made of one piece, all of carbon, and he says his patent is being infringed. The New York Carbon Works, of 18 Cortlandt street, New York, are the sole licensees under the Holtzer patent.

The Campbell Electrical Supply Company, Boston, Mass., has just issued its "Century" catalogue and price list. This is a very neat pamphlet, containing much information, which should be appreciated by dealers in electric wires. The officers of the above company are: Henry F. Campbell, president; Ronald A. Stuart, secretary and treasurer. Mr. George F. Talcott, who has been identified with the Simplex Wire Company, is the manager of the sales department. The offices of the company are located at the corner of High and Congress streets, Boston, Mass.

The Norfolk Suburban Street Railway.—All the capital stock of this company has been subscribed. Of the 750 shares of a par value of $100 each, 396 are held by residents of Dedham, 100 by Boston people, 81 by Hyde Park men and the rest by people in Medfield, West Roxbury and Friendship, Me. The proposed electric street railway is to begin at or near the Court House in Dedham Centre, and to run through High, Milton and River streets in Dedham, West River and East River streets and Hyde Park and Central Park avenues in Hyde Park, and River street in Boston, to a point at or near the Mattapan railroad station.

Proposed Mt. Auburn & Arlington Electric Railway.—Capitalists of Cambridge and Mount Auburn contemplate organizing a company for the purpose of building an electric railway from Mount Auburn, through Payson Park and Belmont, to Arlington. One of the projectors of the scheme says that the company is promised plenty of money, and that applications for locations will be made in the course of a month. The route of the proposed road will be about four and a half miles in length, and will run through much undeveloped real estate, including Payson Park. There is at present no means of communication between Belmont and Mount Auburn or Arlington, and it is consequently thought the road will pay a good dividend within a year.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Jan. 14, 1893.

E. R. Gilman has returned from a trip to the Northwest, where he has been on business matters. He is a heavy dealer in electrical securities, and is also taking an active part in the Great Western Manufacturing Company, of Duluth, Minn.

Wm. H. McKinlock, president of the Central Electric Company, has left for a short trip to New York, with the intention of making arrangements for the spring trade, and to close some important matters which are demanding his attention in that city.

The snows of the past three weeks have given the motors of the various car lines a very good opportunity to hustle, and the dynamo and engines have had to work hard to keep up their end of the line.

Mr. W. F. Richardson, Vice-President and Manager of the Enterprise Electric Company, of Chicago, who has been confined to the house for the past two weeks by a severe illness is out again and able to attend to business.

Mr. Bertram M. Downs, representing William Brookfield, of New York, made the Western office of The Electrical World a welcome call on Monday last. Mr. Downs is making his regular Western trip in the interest of the insulator trade.

The Sebastian Lathe Company, of Cincinnati, is pleasantly located in new and enlarged quarters at 121 123 Culvert street. Mr. Sebastian is manufacturing a very popular line of lathes, both foot power and speed, and is building up a very successful business.

The Chicago Electric Club will hold its third literary meeting at its club rooms, 175 South Clark street, Monday, Jan. 16, at 8 P. M. The evening will be devoted to papers and discussions on electric meters. Samples of various forms of meters will be on exhibition.

A Visit to the Case School of Applied Science shows a number of students being well prepared for the profession of electrical engineers. Prof. Langley is hard at work getting the course into shape and already has much carefully chosen apparatus ready for use.

H. K. Gilman, manager of the Great Western Electrical Supply Company, Chicago, has returned from a two months' trip East, having visited, on business and pleasure combined, New York, Philadelphia, Washington and other cities, and reports his trip a very profitable one for business.

The Central Electric Company has recently placed the Interior Conduit and Insulation Company's system of tubing and ducts in several of the largest buildings in Chicago, St. Louis and other Western cities, the Newberry Library Building, the New Athletic Club, Congress Hall, and several other large buildings in Chicago.

The Indiana Rubber Insulated Wire Company is busy at the factory, at Jonesboro, Ind., to keep up with orders, and its December sales were larger than the preceding months. The Chicago office, in charge of their manager C. J. Butler, reports the business growing rapidly, and very satisfactory to the large trade it supplies.

The Electric Appliance Company reports large and increasing sales of Paranite wire. Two large hotels, the Gault House and the new Briggs House, have just been wired throughout with Paranite wire and several more large buildings are now being wired, and contracts to supply Paranite for a number of others have been closed.

Mr. W. W. Smith, general manager of the M. & K. Telephone Company, Kansas City, is introducing at Great Bend, Kansas, an automatic central station apparatus that has been developed and adopted by the Central Union Telephone Company of Chicago. The system can only be used for a limited number of subscribers, and so far has been adopted at Crawfordsville, Ind., and Great Bend.

Prof. N. Roberts, of the Swan Lamp Company, Cleveland, O., will give an illustrated lecture on "Arc and Incandescent Lighting" at Association Hall, that city, on Jan. 25, at 8 P. M. Those who will be able to attend will be fortunate, indeed, as there are few so competent as Prof. Roberts to treat this most interesting subject. The new firm of E. P. Roberts & Co. will have its offices at 411 Western Reserve Building, Cleveland, O.

The Lundell motors, made up to 5 h. p., which have recently been put upon the market by the Interior Conduit and Insulation Company of New York, and are being introduced in the West by the Central Electric Company, are meeting with a ready sale, and that company has already installed several of them in their territory. They have issued a complete descriptive circular and would be pleased to furnish the same to any one desiring information bearing on the above.

G. M. Gest, Cincinnati, special agent representing J. G. White & Co., of New York, has perfected his arrangement for the handling of a large line of contract work, including tracklaying, etc. All electrical contracts will be taken in the name of the New York firm. Mr. Gest has had a long and varied experience, and, representing a firm with the reputation enjoyed by his New York house, will undoubtedly be able to secure a large share of the business in Cincinnati and vicinity.

The National Electric Manufacturing Company, of Eau Clare, Wis., sold last week, through its Chicago office, of which Mr. Paul Bossart is the representative, one 2,500-light generator with transformers, to the Northwestern Electric Light and Power Company, Chicago, and also a 1,000-light machine with an equal capacity in transformers to Swift & Co., Chicago. The National Electric Company has recently increased its capacity and under Mr Daugh's management is doing a very handsome business.

Dr. Henry Crew, professor of physics in Northwestern University, has commenced a course of university extension lectures on "Electricity and Magnetism" in the lecture room of the physical laboratory of the university, at Evanston, under the auspices of the centre organized by the Woman's Club: Jan. 16, "Production of Electric Currents;" Jan. 23, "Some Properties of Electric Currents;" Jan. 30, "Magnetism;" Feb. 6, "Magnetic Induction;" Feb. 13, "Relation of Light and Electricity." The lectures will be fully illustrated with experiments.

A visit to the new power house of the Woodland Avenue & West Side Street Railway Company reveals a very interesting plant of the general character which some recent writers have called the "ideal." Mr. Waterman, the electrical engineer in charge for the Westinghouse company, is working hard to produce a station well equipped electrically, and the mechanical engineer for the company, Mr. Shane, is doing his share of good work. As is well known marine engines are being installed—everything, engines, pumps, stack poles, etc., is built of the "vertical" type.

Mr. Fred L. Wolfrum, formerly representing the Detroit Motor Company, and later the Jenney Electric Motor Company, in Chicago, has recently been appointed agent for the Commercial Electric Company of Indianapolis, with headquarters in Room No. 455 "The Rookery." Mr. Wolfrum is a young man, but his very successful work in the introducing of the Jenney motor and the Detroit Motor Company's apparatus in Chicago places him in the front rank as a "hustler." Mr. Wolfrum has made two or three handsome sales for his new company, and will undoubtedly be successful in his new field.

Mr. Leo Daft, the well known electrical engineer, now of Everett, Wash., was in Chicago for some days during the past week. Mr. Daft is representing a syndicate that is building a new town in Washington, 35 miles north of Seattle. The syndicate is a very wealthy one, and expects to put in a large manufacturing installation to be run by water power, 15 miles distant, using a current of 10,000 volts. While in Chicago Mr. Daft purchased a large invoice of machinery and a 150-light arc generator, and it is expected it will take at least one year to complete the work. Mr. Daft returned to Washington on Friday last.

The Electric Appliance Company is opening the season by making a particular push on the New England double pole switches. It has held the agency for this switch for the past year and has placed a large number of them, although they have always been high in price. The manufacturers have known that they had a good thing, and as they have always had all the orders they could handle, have not cared to reduce their price to the basis of other makes. Having increased manufacturing facilities now, however, it has been decided to make a cut in price and increase the business, and the Electric Appliance Company is preparing for a largely increased demand.

The Commercial Electric Company, of Indianapolis, has recently appointed the following agents: Chicago, Mr. Fred Wolfrum, 455 The "Rookery"; St. Louis, E. G. Bruckman, of the Electrical Engineering Company, Equitable Building; Louisville, Southern Engineering Company, 238 Fifth street; Cleveland, W. D. Graves, Electrical Manufacturing Company, 8 Case place; Toledo, Bissell & Dodge, 518 Summit street. The Commercial Company has in a short time built up what promises to be a very successful business for a concern so young, seeming to indicate that the trade appreciate the desirable features of its machine. Mr. A. D. Adams, the manager and electrician of this company, has had a wide experience in this class of work and is the inventor of the apparatus the company is manufacturing. Mr. Adams and his associates are to be congratulated on the bright outlook for the building up of a successful enterprise.

McLean & Schmitt, contractors and electrical engineers, 195 South Canal street, Chicago, have recently installed an isolated lighting plant for Mr. John York, 779 South Halstead street. This plant is for use in a fine new clothing store, 125 feet front and 110 feet deep, four stories and basement, owned by the gentleman named. The plant consists of a 150-light Hochhausen generator and a 125-light Edison incandescent generator. The power used is a 100 h. p. Hoffman & Billings Corliss engine and an 80 h. p. Russell engine. Something like 100 arc lights are burned on the front of the building as an advertisement, making one of the finest displays in the city. McLean & Schmitt have only recently commenced business, but have secured in a short time a number of fine contracts. The plant referred to has been installed in an elegant manner and reflects much credit on their mechanical and electrical ability.

The Great Western Electrical Manufacturing Company, of Duluth, Minn., has recently been organized with a capital of $1,500,000, with T. B. Casey, who is a director in the Northwest National Bank, Minneapolis, president. Rogers S. Munger is first vice-president, and is president of the Imperial Mills Company, Duluth, Minn. Col. C. H. Groves is second vice-president, and is also president of the Lake Superior Elevator Company. H. A. Odell, of Chicago, is secretary and treasurer. E. R. Gilman is general manager, and is also general manager of the Great Western Electrical Supply Company, of Chicago. This new firm has taken the large buildings at Duluth, formerly used by the Iron Bay Company, and will manufacture all kinds of electrical specialties formerly manufactured by the Great Western Electrical Company, of

Chicago. They will also manufacture dynamos, motors, mining locomotives and all kinds of insulated wires. The Chicago Insulated Wire Company, having been sold to the Great Western Electrical Supply Company, will have their different brands of wire manufactured at Duluth. This new firm is one of very large capital and men of prominence, wealth and ability, and goods that are valuable and important to the electrical business will be manufactured by them.

CLEVELAND, O., Jan. 14, 1892.

The firm of E. P. Roberts & Co., the "company" being Mr. C. J. Uebelacker, is fitting up very pleasant offices in the Western Reserve Building. They are doing a consulting business and also are making a specialty of indicating and registering apparatus, handling a number of well known instruments for engineering measurement, such as Weston's voltmeters and ammeters, Bristol recording gauges, Calkin's steam engine indicators, Van Winkle's transmitting dynamometers, and, in fact, a general line of indicating instruments

The Ohio Construction Company is a new corporation composed of men well known in electrical circles, and who appear to be well equipped to hit the mark at which they aim, which is first class construction The president is Mr. C. W. Wason, who is also vice-president of the East Cleveland Street Railway Company. The vice-president and treasurer is Mr. B. M. Barr, the secretary Mr. P. B. Huyette, and the manager Mr. H. L. Browning. The headquarters are at 54 Frankfort street, Cleveland, O., the other quarters being anywhere where kicking is *not* to be done.

At the meeting of the Civil Engineers Club of Cleveland Jan 10 Prof. Langley read a most interesting paper, which was also a contribution to science. It dealt with the variation in the physical characteristics of steel with variations in chemical constituents. To the electrician much of interest was given in the professor's remarks relative to the magnetic qualities of steel, or rather the loss of magnetic qualities, when at the temperature of recalescence, and the professor's remarks relative to the commercial applications of this fact were full of suggestion. Much of the matter given was original and of great interest and scientific and commercial value.

Discussion on Grounded Circuits.—At the meeting of the Cleveland Electric Club Jan. 4 Mr. J. P. McKinstry, general manager of the telephone companies of Ohio, Arkansas and other States, read a most interesting paper, dealing primarily with the underground wires of the Cleveland Telephone Company, but also touching on the experience of the telephone companies of many cities. The discussion was animated and became especially so when it took the line of the injury done to the lead coverings by the currents from electric roads. As several of the city fathers were present, as was also the city electrician, and as the electric roads were represented, and, in addition, constructing engineers, consulting engineers and pure scientists, the subject received an all around attention. The discussion was participated in by Prof. Langley, Mr. Hoag, Mr. Waterman, Prof. Morley, Mr. Davis, Mr. Barr, Prof. Roberts, Mr. Wason, Mr. Uebelacker and others.

DETROIT, Mich., Jan. 14, 1893.

Norman McCarty, representing the Westingbouse Electric Manufacturing Company, at Pittsburgh, Pa., was in Detroit a few days last week.

David McCormick has taken for a partner T. Linn Bradford, and the firm, which is now known as McCormick & Bradford, has removed from Griswold street to 11 Clifford street, where it will continue in electrical repairing business.

Wm. A. Turbayne, of the Turbayne Electrical Specialty Company, has been appointed Electrical Inspector for the Michigan Inspectors' Bureau for the State of Michigan, whose duties will be to inspect all electric installations that occur in that State.

William M. Porter, Detroit, Mich., recently manager of the Edison Electrical Company at Detroit, having severed his connection with that company, has taken the agency of the Ball & Wood engines for Michigan and northern Ohio, with headquarters in Hodge's Block, Detroit. Mr. Porter is very well and favorably known in Michigan and Ohio, and will no doubt prove a successful representative in this line of work.

The Fontaine Crossing Company, of Detroit, Mich., with its excellent large machine shop, is doing considerable business in its line of work and has made numerous improvements in its Fuller electric lighting machine. It has recently shipped one 200-light dynamo to the Temple Manufacturing Company, Muskeegon, Mich.; one 500-light to the Grand Rapids (Mich.) Chair Company; one 50-light to the Valley City Milling Company, Grand Rapids, Mich., and Buffalo; for the Anchor Line Steamship Company for steamers India," Japan and China, each a 250-light automatic Fuller dynamo.

Fisher Electric Company, Detroit, Mich., is very busy in all of its departments, and has recently installed a number of plants, among which are the steamers Alpena and Mackinaw at Cleveland, each one 500-light machine; Tifft House, Buffalo, N. Y., two 500-light dynamos and a complete bell system of 15 calls to each indicator, also engines and dynamos combined in the gun boats Machias and Castine at Boston. These installations are made complete in all of the departments. The work it has done has given the company quite a trade in marine business, it having installed about 90 per cent. of the isolated plants now in use on the lakes. Its business has increased so much of late that it anticipates enlarging their factory.

The Commercial Electric Company, Detroit, Mich., agent for the Standard arc and National transformer system, has recently closed contracts for the following plants: Carson City Electric Light and Power Company, 40-lights Standard arc and a 500-light National machine; Marine City, Mich., 40-light Standard arc; Allegan, Mich., 40-light Standard arc; City of Coldwater, 1,000-light National; City Electric Light Company, Kalamazoo, Mich., 1,000-light National; F. Miller, Caro, Mich., 500-light National incandescent, 40-light arc; A. L. Bryant, Mayville, Mich., 500-light National incandescent; Citizens Light and Power Company, Kokomo, Ind., 50-light Standard arc, and 1,000-light National incandescent; Holly Electric Light and Power Company, Holly, Mich., 40-light Standard arc, 500-light National incandescent.

The Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., has recently put in some equipments on the Detroit Citizens' Street Railway, three machines on the Jefferson avenue line, four on the Mack road, and has ten car equipments on hand there ready for new cars soon expected. It has also put in one 250-h. p. generator at the power plant. Mayor Pingree, of Detroit, Mich., has since determined to have Detroit own its own electric light plant, and there seems to be no doubt but he will succeed in his efforts, as he has just been to Pittsburgh and visited the Westinghouse Electric and Manufacturing Company, and also the Western Electric Company, of Chicago, who will put in bids for the same. There seems to be considerable competition here by the different firms for the contracts for the city electric light plant and the new street railway plant, which will amount to over one-half million dollars.

Detroit City has not yet made any contract for city lighting, and there is considerable talk of putting in its own plant. Another company, however, has been organized, and will be ready to offer its bid to do the lighting when the time comes, within the next 30 days. This new company is called the Standard Electric Illuminating Company, of Detroit, with $500,000 capital, with the following prominent business men and capitalists: Geo. E. Fisher, secretary and manager; J. B. Moore, Waldo M. Johnson, A. G. Lindsey, Frank Howard, G. W. Bates and others. This new company will also sell electrical apparatus and such other articles as may be necessary in their business. Mr. Fisher is well and favorably known in the electrical field, and is the manager and secretary of the Commercial Electric Company, and has had considerable experience in electrical matters. He now handles the Standard arc (improved Sperry) system, national alternating incandescent, and Fisher automatic (direct current) incandescent systems.

The Detroit Electrical Works have recently removed their offices from the factory on Woodward avenue to the Campau building down town, where they occupy nine offices on the third floor, suitably arranged for their large business, the factory offices being now required for draughtsmen and other employés. They have, after considerable competition and careful investigation, been awarded the contract by the Calumet Street Railroad Company, of Chicago, Ill., for eight 100-k. w. generators, fourteen 40-h. p. motors and equipments, switchboards, etc., for the same. This makes the seventh order for equipments and third order for generators, and it will be one of the finest stations in the United States. They also have just received the second order from the Bell City Street Railway Company, Racine, Wis., for motors and generators, and for the Detroit Citizens' Street Railway Company's power station and they have put in four 150-k. w. generators, supplied all the equipments for the Jefferson and Woodward avenue electric cars, and for the Mack Avenue and Grosse Point electric branch. The Detroit Electrical Works are very busy in all their departments.

The Huyett & Smith Manufacturing Company, Detroit, Mich., which manufactures hot blast apparatus, ventilating fans, blowers, engines, boilers, and electric heating plants, has just put in one of its first electrical heating plants for the International Trust Company, Boston. It is said this is the first one put up in this country. It used the Smith hot blast apparatus, made of coils of pipe arranged horizontally, and so any one coil or pipe can be changed without interfering with the others. When necessary these are inclosed in a steel jacket, with wrought iron frames. The fan attached to this heater is the Smith disc fan blower, being of lightest and strongest possible construction, giving a moderate velocity, with a great volume of air that is given a centrifugal motion. This fan is attached directly to a Fuller electric motor, evenly balanced and supported by the frame or spider of the fan, the shaft of which is extended to form the shaft of the armature, and does not interfere with the air space of the fan. The speed is regulated by means of a switch, doing away with the use of resistance boxes, and the different sizes can be run at three different speeds each, thus a 24-inch can run at a speed of 600, 700, or 900.

TACOMA, Wash., Jan. 10, 1892.

The Northwest General Electric Company recently sold through R. S. Hill, to the Blatchly Lithographing Company, of Tacoma, a 14-h. p. motor.

The Union Electric Company, of Seattle, has installed in the Pine street station a 2,000-volt Thomson-Houston alternating machine, having a capacity of 2,500 incandescent lights.

The Sunset Telegraph and Telephone Company has greatly enlarged its Tacoma exchange by the addition of several new rooms to accommodate the switchboard for the long distance lines through the State.

The Commercial Electric Light and Power Company, of Tacoma, will operate 220 incandescent lights in the Annie Wright Seminary, which has just been wired by the Consumers' Supply Company; also 65 lights in the new Methodist church.

The A. F. Espersen Company, of Tacoma, has received the contract for wiring the Murray building for 200 incandescent lights. The company recently placed 150 colored incandescent lamps in the Olympic Theatre. Many orders have been received for the Arnold flexible brackets.

Guy C. Phinney has applied for a franchise for an electric line from Pioneer place to Woodland Park at Seattle. The road will be five miles long and will be double tracked. The cars will be 36 feet in length and will be finely fitted inside. Brill trucks, Genett air brakes and Ahearn electric heaters are to be used.

The House Electric Light and Power Company, R. C. Larsen, manager, has been organized in Tacoma for the purpose of lighting the buildings fronting on Pacific avenue, in the block between Ninth and Tenth streets. An electric station has been fitted up in the basement of the Mahncke and Muhlenbruck buildings, from which overhead wires will be strung for both arc and incandescent lights. A 500-incandescent light Rockford dynamo is already in operation, supplying also a number of Ward arc lamps on 125-volt circuit. A duplicate machine will be added, driven by a Watertown automatic engine.

News of the Week.

THE ELECTRIC LIGHT.

Kendallville, Ind., will soon be lighted by electricity.

New London, O., is considering the electric light question.

Plymouth, O., may have an electric light plant in the near future.

The Crown Point (Ind.) electric light plant will be sold by the sheriff on Jan. 28.

The Durand (Wis.) Electric Light Company is negotiating for an electric power plant.

The Springfield (O.) Light and Power Company has decided to enlarge its plant at a cost of $60,000.

Westport, Mo., wants an electric light plant of its own, and will probably hold an election for that purpose.

The Tipton (Ia.) water-works and electric light plant were recently destroyed by fire at a loss of about $6,000.

The Missouri lines of the C., B. & Q. Railroad are to be equipped with electric lights; the storage battery system will be used.

The Hackensack (N. J.) Electric Lighting Company has purchased a site along the river front of 226 feet, and will erect a new plant with increased lighting capacity.

The Fort Wayne Electric Company has made a proposition to the Palmyra (N. Y.) village trustees for lighting the streets by electricity, and it is quite probable that it will be accepted.

The Laurel (Md.) Electric Light, Heat and Power Company, which has the contract for lighting that city with electricity, has been compelled to suspend operations during the past week on account of the frozen condition of the ground.

THE ELECTRIC RAILWAY.

The Fort Lee Electric Railway is now under construction. This railroad is expected to run to Hackensack, N. J., by two routes.

Proposed New Electric Railways at New Haven.—Among the proposed new electric roads at New Haven are the Fair Haven & Westville road in New Haven, the Bridgeport Horse Railway Company, in addition to a charter for a new road, the Norwalk Tramway Company, and the Norwich Street Railway Company, which asks for an amended charter and permission to use electric power. In many instances permission is asked to cross town limits, thus connecting one or more towns, as for instance in the case of one petition which connects Bristol, Plainville, New Britain and other towns. Another petition is signed by J. W. Nichols, and others of New Haven, who wish to build a line extending from Bramford to Woodbridge, passing through East Haven, New Haven, Orange and Hamden, a total line mileage of about 16 miles.

The Chicago & St. Louis Electric Railroad.—A bill was introduced into both branches of Congress a few weeks ago to encourage the construction of electric railroads, an abstract of which was given in THE ELECTRICAL WORLD of Dec. 24, 1892. On Jan. 11 a hearing was given before the Committee on Commerce. Dr. Wellington Adams was present in behalf of his company, while the General Electric Company was represented by Mr. Eugene H. Lewis. Senator Vest, of Missouri, said that he could not understand how the securing of apparatus abroad could damage the General Electric Company if it were true that that company was furnishing apparatus of the same nature to European customers. It was claimed that all such enterprises had been granted government aid and that in the present case no subsidy or grant of land or money was asked. The representative of the General Electric Company urged that the granting of such a bill would be detrimental to its interests, and that it was able to supply apparatus as cheap and efficient as any that could be secured abroad.

MISCELLANEOUS NOTES.

Electric Starting Signal.—A new system of train starting has been inaugurated in the Dearborn station in Chicago. A large clock in the train dispatcher's office runs by electricity. Connecting wires run to large gongs in the different waiting rooms and in the train shed. Two minutes before the train starts the different gongs ring in all parts of the building.

The Invention of a Yale Student.—Mr. Chas. B. Bliss, a student graduate of the Department of Psychology at Yale, has invented an instrument known as the Bliss multiple key, which will prove of considerable importance in the delicate investigations on metal reaction. The key will simultaneously break or make several circuits in any order and will regard variations of one ten-thousandth of a second.

The Fort Wayne Electric Company's Loss Adjusted.—The fire loss of the Fort Wayne Electric Company has been satisfactorily adjusted at $32,625. There were only two adjusters, Frank Van Voorhis, of Chicago, and John C. Ingram, of Indianapolis. They represented over $500,000 of insurance, and were assisted by Capt. William Brophy, of Boston, who represented the Eastern mutuals and was also inspector. The work of repairing is progressing rapidly and there has been but little delay to manufacturing.

Industrial and Trade Notes.

The Consolidated Electric Manufacturing Company, of Boston, Mass., has issued a neat little pamphlet describing the apparatus manufactured by them which includes almost everything in the way of arc lamps, cut-outs, switches, bells, annunciators, lamp shades and stands, and motors and dynamos.

The W. & S. Hydraulic Machinery Works, of 204-10 East Forty-third street, New York City, has issued a new catalogue giving illustrations and descriptions of the company's hydraulic jacks, punches and rail benders, pumps, polishing machinery, etc. Watson & Stillman are the proprietors of this company.

The Knapp Electrical Works, of Chicago, are doing a large business at the present time in electrical supplies; this, of course, might be expected, as this firm is a well-known and old established firm in manufacturing and jobbing electrical supplies of all kinds. One of their specialties is electrical wire, of which they have just shipped two carloads to the Duluth Street Railway Company.

The Scranton Traction Company, of Scranton, Pa., has placed the contract for the buildings of its new plant with the Berlin Iron Bridge Company, of East Berlin, Conn. The boiler and engine room will be 65 feet wide by 200 feet long, with a machine shop and car shed 93 feet wide and 225 feet long. The entire plant will be fireproof, of the well known Berlin construction.

Crompton & Co., Limited, London and Chelmsford, England, have sent out a handsomely illustrated catalogue of the various supplies manufactured by them. This company, which is affiliated with the Crompton Howell Electric Storage Company, Limited, of London, and the Crompton Electric Supply Company, of Australia, manufactures the highest class of machinery of every description for the electric transmission of power, lighting, smelting, welding, electroplating, etc.

A Good Recommendation.—Messrs. Waterhouse, Gamble & Co., manufacturers of improved arc lamps for arc and incandescent circuits, have received the following excellent testimonial from Geo. W. Phillips, of the Norwich Electric Light Company, of Norwich, Conn.: "The lamp we received from you a few weeks ago works first class. We put it on and tested it with a ⅝ plain carbon, and it burnt 14 hours and 15 minutes actual time. I have since placed it out upon the street and it is working first class. I consider you have got as good a lamp as I have ever seen."

The E. P. Gleason Manufacturing Company has just broken ground for the erection of a four story building to be an addition or extension to its already large glass works in Brooklyn. The new buildings will be used principally for finishing glassware for illumination, *i. e.*, polishing, cutting and etching the articles after they have gone through the glass house proper. The company erected two buildings last summer to increase the output of its glass factory, and this building is now necessary, as the finishing shop, which at present consists of a three story building 100 feet front by 150 feet deep, is too small for the increasing trade.

The Burton Electric Company, of Albany, N. Y., was recently organized and incorporated with a capital of $10,000. The officers of the new company are Paul G. Burton, president; Chas. P.

Frey, secretary, and Howard Martin, treasurer. This company was formed in order to better meet the demand for Mr. Burton's services and the apparatus which he has manufactured. Mr. Burton began business in a small way in August, 1891, and the formation of such a company has grown to be a necessity. The plant of the Consolidated Car Heating Company, the Hinckel Brewery, and a large number of smaller factories and residences in Albany have been equipped with Burton apparatus.

A substitute for hard rubber, and at much below its cost, has found its way on the market in a material under the name of "Fibrone" manufactured by the Fibrone Terraloid Company, at 91 Oliver street, Newark, N. J. This material, besides the numerous useful novelty and advertising articles to which it is readily and perfectly adapted by pressure, and assuming any color desired, is, because of its being a non-conductor of electricity and an exact imitation in appearance of hard rubber, being successfully produced in electrical fittings, having now reached a popularity by which the company is much encouraged for the care, study and experimental tests to which it has been subjected. Among the electrical articles may be mentioned lamp keys, bushings, Edison lamp rings, switch keys, telegraph instrument handles, battery jar covers, telephone receivers, bell box covers, push button centres, handles for 5, 10, 50, and 100 ampère switches, etc.

The Detroit Motor Company has during the past sixty days sold the following plants complete: Pingree & Smith, Detroit, 1,300 incandescent lights; Lead Pipe and Sheet Lead Works, Detroit, 600 incandescent lights; Standard Pearl Button Company, Detroit, 200 incandescent lights; McAlpin Shoe Company, Detroit, 100 incandescent lights; U. S. Frumentum Company, Detroit, 200 incandescent lights; American Brass and Metal Company, Detroit, 200 incandescent lights; Michigan Brass and Iron Works, Detroit, 1,000 incandescent lights; Commercial Mills, Detroit, 250 incandescent lights; Wolverine Manufacturing Company, Detroit, 100 incandescent lights; National Pin Company, Detroit, 200 incandescent lights; Rumsey Manufacturing Company, Detroit, 250 incandescent lights; *Evening News*, Detroit, 1,000 incandescent lights; *Detroit Journal*, Detroit, 800 incandescent lights; Fred Stearns & Co., Detroit, 300 incandescent lights; Lyceum Theatre, Detroit, 1,000 incandescent lights; Bay City Electric Light Company, Detroit, 640 incandescent lights.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filter for sale cheap; send for prices to Purity Oil Filter Manufacturing Company, 901 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

UNITED STATES PATENTS ISSUED JAN. 10, 1893.

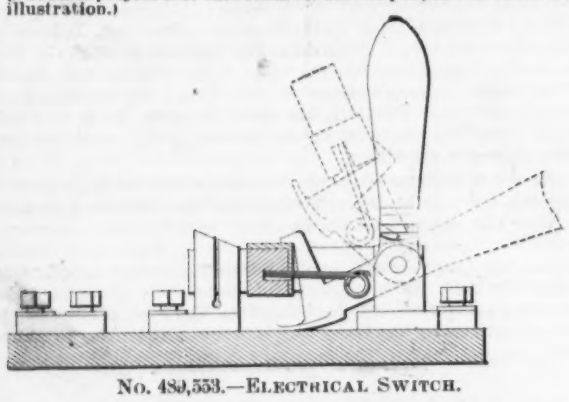
489,481. Electric Railway Trolley; Ernest H. Jenkins, of Winfield, Md. Application filed July 20, 1892. The combination with the pole having a socket provided with an annular shoulder, of a bracket having a shank provided with an annular shoulder, and slotted longitudinally near its lower end, the transverse pin, the coiled spring arranged between the annular shoulders, and the trolley wheel.

489,522. Galvanic Battery; William C. Cahall, of Philadelphia, Pa. Application filed Sept. 29, 1891. As a negative element in galvanic batteries, the plate composed of the oxide of antimony intimately combined with carbon.

489,526. Electric Lighting System; Harry M. Doubleday, of Pittsburgh, Pa. Application filed April 21, 1892. The combination of two or more incandescant electric lamps, an adjustable reactive coil, conductors leading therefrom to the respective lamps, and an adjusting switch device interposed in each of said conductors between the respective lamps and the reactive device.

489,553. Electrical Switch; George Baehr, of Brooklyn, N. Y. Application filed March 26, 1892. In an electric switch, the combination of a pair of circuit controlling blades, a crossbar of insulating material mechanically connecting them together, a manually operated swinging lever provided with two jaws loosely embracing said crossbar, and a spring bearing at one end against the lever and at the other end against the crossbar. (See illustration.)

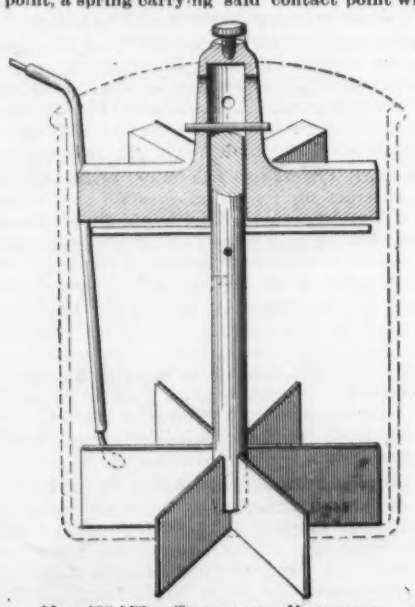
489,559. Galvanic Battery; George L. Foote, of Brooklyn, N. Y. Application filed Sept. 13, 1892. In a galvanic battery the combination of an electrode and a post supporting the same from below, the electrode provided with a chamber into which the post projects and means for adjusting the distance which the post shall project into said chamber for the purpose set forth. (See illustration.)



No. 489,553.—Electrical Switch.

489,563. Electric Railway; Daniel Edson Kimball, Topeka, Kan. Application filed Jan. 11, 1892. In an electric railway the combination of the main and sectional conductors, a series of rock shafts and switches between the main and sectional conductors operated by the rock shafts, cranks on the ends of the rock shafts, the cranks on the successive pairs of rock shafts being joined by a bar pivoted thereto and a device carried by the vehicles co operating with the bar to close said switches. (See illustration.)

489,570. Spring-Jack Switch; Charles E Scribner, Chicago, Ill. Application filed Dec. 27, 1880. The combination with a spring-jack switch of a loop plug inserted therein, the main lever of said switch being lifted by said plug from its normal contact point, a spring carrying said contact point which closes



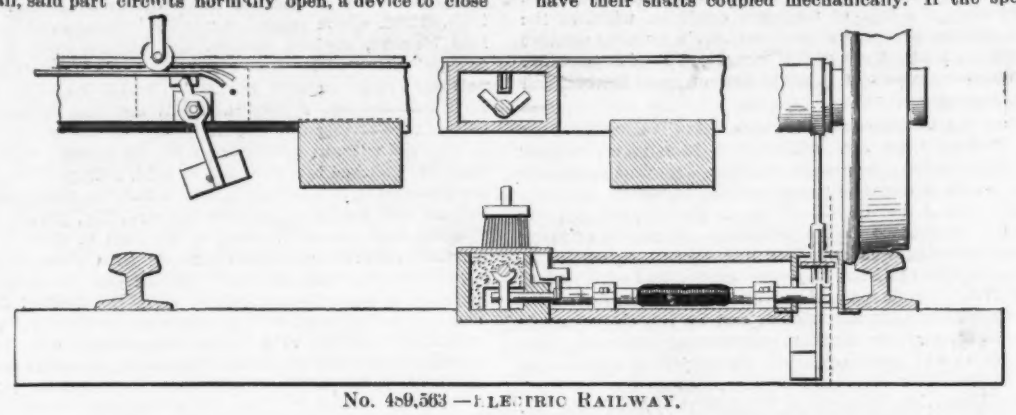
No. 489,559.—Galvanic Battery.

upon a testpiece of the switch when the main spring is lifted, and the insulated rings or terminal which is closed to the other point of the loop plug, whereby the two line terminals of the switch are connected with different points of the plug and the testpiece of the switch connected with the normal contact point of the main spring or lever.

489,571. Spring-Jack Switch for Telephone Exchanges; Charles E. Scribner and William R. Patterson, Chicago, Ill. Application filed Jan. 21, 1892. In a spring jack switch a pair of springs or contact pieces insulated from one another by a strip of rubber or other insulating material, said material extending throughout such lengths of the springs as are straight lines and adapted to flex when the springs are flexed, whereby said contact springs are insulated from one another and adapted to move together when flexed.

489,573. Conductor System for Electric Railways; George Wilhelm von Siemens, Berlin, Germany. Application filed Feb. 3, 1892. In an electric railway the combination with a contact conductor composed of a series of relatively insulated sections, a supply conductor, normally interrupted connections between the supply and contact conductors, and electromagnetic device for each section, comprising electromagnetic circuit completing and locking means, and a series of armatures adapted to be operated by an electromagnetic device on the car to operate the circuit closing device of one section and release the lock of the preceding section. (See illustration.)

489,597. Multiphase Railway System; Francis B. Badt, Chicago, Ill. Application filed Feb. 19, 1892. In an electric railway system the combination of exposed conductor rails arranged in groups of sections and adapted to be brought into circuit with a moving motor with insulated main conductors, a multiphase generator connected with such mains, a series of converters each having primary coils permanently in the main circuit and secondary coils having part circuits terminating at each end in one exposed rail, said part circuits normally open, a device to close



No. 489,563.—Electric Railway.

the same on the approach of the car, said device including a conductor permanently connecting successive groups of rail sections so as to make a permanent connection between them, and a multiphase motor on the car.

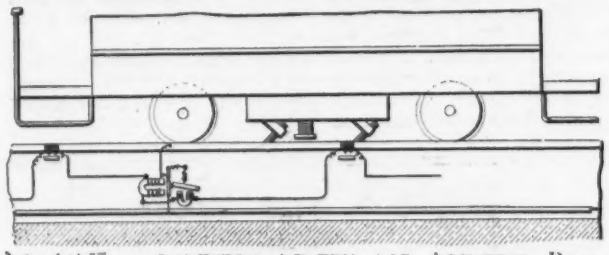
489,598. Electric Lighting System; Francis B. Badt, Chicago, Ill. Application filed Oct. 22, 1892. The combination of the conductors of a multiphase system with a group of incandescent lamps, the filaments of which are connected in series and conductors leading each from one main line conductor to a point in the series circuit between a pair of lamps.

489,603. Attachment for Telephones; James L. Davidson, Pittsburgh, Pa. Application filed Oct. 8, 1892. An attachment for telephones consisting of a sheet metal structure having a tablet-support at one end, a support for a calendar or like device below the surface of the structure at the opposite end, an opening for displaying the calendar, and means for securing the attachment to a telephone box.

489,616. Electric Gas Lighting Apparatus; Aaron M. M. Sloss, of Kansas City, Mo. Application filed March 24, 1892. The combination with a gas fixture or lamp of a battery, a spark-coil, and a detachable case containing said battery and spark coil, formed in two parts and surrounding the main supply of said fixture or lamp.

489,629. Railway Signal; William F. Z. Desant, New York, N. Y. Application filed April 25, 1892. A semaphoric signal consisting of a pivoted semaphore arm having an operating lever, the free end of which bears normally on any one of a series of pins carried by a power impelled gear wheel; a retarding device as a fly fan rotated by the same train; a notched controlling disc and an electromagnet provided with an armature lever having two arms, one of which checks the fly fan while the other regulates the movements of the semaphore arm.

489,653. Electric Gas-Lighter; Thomas W. Lane, Boston, Mass. Application filed Jan. 25, 1892. In an electric hand-lighting gas burner having a fixed electrode and a two-armed angle or bell-crank lever rigidly attached to the gas-cock and carrying the movable electrode, the combination of a lever handle for moving said two-armed lever with a leaf spring attached to the burner



No. 489,57 onductor System for Electric Railways.

body, and its free end adapted and normally tending to hold the gas-cock in either an open or in a closed position and to be strained only during the opening or closing of the gas-cock.

489,658. Strain Insulator; Louis McCarthy, of Boston, Mass. Application filed June 29, 1892. An insulator comprising a case adapted to hold a series of sheets of mica, a metallic connecting piece placed therein, and a series of sheets of mica surrounding said piece and adapted to insulate the same from said case, a sleeve secured within said case at one end and provided with a screw threaded bolt or connecting piece whereby as the sleeve is turned the connecting piece may be screwed into or out of the sleeve to tighten or loosen the supporting wire.

489,668. Electric Battery; Clarence H. Bryan, of Chicago, Ill. Application filed May 3, 1892. An excitant compound for dry electric batteries comprising a mixture of a salt of calcium, a ferrous salt and a salt of hydrargyrum.

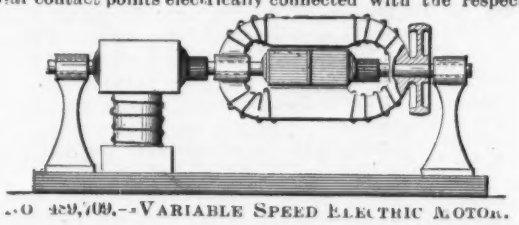
489,674. Loop Switch; Frederick D'A. Goold, of Schenectady, Assignor to the Edison General Electric Company, of New York, N. Y. Application filed April 15, 1892. The combination in a snap switch of stationary contacts, a pivoted or rotatable switch member, a spring against the under side of which said contacts bear, a switch arm pivoted at one side of said body but extending over the same, and a spring, the ends of which are connected respectively to the arm and the rotatable switch member on the pivot of said arm.

489,682. Lamp Socket; Amandus Metzger, Schenectady, N. Y. Application filed April 26, 1892. The combination, in a socket, of an insulating base or body, an extension thereon, rising from the centre of the body at a considerable distance from the periphery of the body, a sleeve terminal secured to the outer end of said extension, a second terminal also secured on the end of said extension, and a shell resting on the base near its periphery and at a distance from said extension but surrounding the same.

489,687. Means for Controlling Electric Motors; John F. Ott and Arthur E. Kennelly, Orange, N. J. Application filed May 7, 1891. The combination in a switching apparatus of a stationary cylinder on the surface of which are a series of contact strips of plates, a spindle passing through said cylinder, means for turning said spindle, and an arm having contact devices co-operating with said contact strips and moved by the spindle, means for preventing more than one successive rotation of the spindle in the same direction whereby the switch-arm is moved over the cylinder contacts, first in one direction and then in the other.

489,739. Variable Speed Electric Motor; Carl Hering, Philadelphia, Pa. Application filed April 30, 1892. Two electric motors, one fixed and the other capable of revolving as a whole, have their shafts coupled mechanically. If the speeds of the armatures in their respective fields are the same in both motors there will be no tendency of the second motor to revolve as a whole, but if these speeds are made to differ from each other the second motor will revolve as a whole at a speed equal to the difference between the two speeds of the armatures in their respective fields; this ultimate speed, which is the one at which the motors drive, can therefore be made to vary from zero to the sum of the two speeds. (See illustration.)

489,7 6. Railway-Signal; John E. Geary, Syracuse, N. Y. Application filed Dec. 29, 1891. In a railway train indicator the combination with a controlling instrument having a dial provided with a series of radial contact points, and an hour and minute hand geared to move relatively in the same ratio as an ordinary clock of a clock indicator having a series of similarly arranged radial contact points electrically connected with the respective



No. 489,739.—Variable Speed Electric Motor.

contact points of the controlling instrument, an hour and minute hand, the latter electrically connected with the minute hand of said controlling instrument, a battery and electromagnet in circuit with said hands, a spur-wheel on the minute hand shaft and an armature detent, adapted to be operated when the circuit is closed, to hold the clock hands in position corresponding to the position of the hands of the controlling instrument when set.

489,739. Socket-Switch for Incandescent Electric Lamps; Louis Henry and Louis N. Dalysson, Newark, N. J. Application filed Oct. 10, 1892. The combination with a supporting block of a switch lever pivoted thereto and having a projecting arm, a spring contact arranged in the path of said arm, and adapted to engage and hold the same in position, said switch lever having a shaped face, a stem guiding said supporting block above said switch lever and having an enlarged outer end, a spring arranged in said stem between said enlarged outer portion and its bearing in the supporting block, and a shifting blade, secured to said stem, and arranged to engage said shaped face of the switch lever.

489,764. Underground Electric Railway; James B. Sheldon, Daniel J Murnane and George L. Van Beek, St. Louis, Mo. Application filed June 22, 1891. An underground electric railway, consisting of a motor car, supports secured to the truck frame of said car, a contact plate secured to said supports and adapted to travel in the subway, a series of swinging or pendulum-like switches, located in the subway and in electrical connection with an insulated main supply conductor, said switches adapted to be engaged only at their free ends and operated by said contact plate, whereby electrical connection is made between said main supply conductor and the motor.

489,832. Galvanic Battery; William Robert Reud, New York, N. Y. Application filed June 2, 1892. A galvanic battery of cylindrical shape, having concentric poles, and a bail secured to one end of the battery.

489,835. Closed-Conduit Electric Railway; Charles A. Stark, Duluth, Minn. Application filed March 23, 1892. An electric railway, comprising a surface conductor, a line wire held in a conduit adjacent to the surface conductor and adapted to connect therewith, a compressible rail, and means for closing the circuit through the surface conductor by the movement of the rail.

489,861. Bracket for Electric Light Wires; George H. Bennett, Cincinnati, O. Application filed Nov. 16, 1891. The object of the invention is to keep the electric wires for both arc and incandescent light a sufficient distance from the walls and ceilings of rooms, thereby preventing or making impossible leakage and conflagration.

489,883. Electric Car Truck; Thomas Tripp, Avon, Mass., and Aretas Blood, of Manchester, N. H. Application filed June 30, 1892. In an electric vehicle truck, the combination of two axles, loose wheels adapted to rotate on said axles, gears connected with said wheels, two independently rotatable shafts provided with armatures field magnets, and pinions on said shafts, each pinion meshing with the two gears connected with the wheels of one side of the truck.

489,902. Electric Prison Cell and Guard; William S. Hull, Sheffield, Ala. Application filed Sept. 22, 1891. A lattice for jail cells and the like comprising pipes, insulated conductors forming a circuit passing through said pipes and a battery and alarm included in the circuit of said conductors.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.